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THE RED-TAILED HUMBLE BEE.

A STUDY IN MIMICRY.

By G. W. BULMAN, M.A., B.Sc.

AMONG our seventeen native species there is none more easily recognised than the Red-Tailed Humble Bee, the *Bombus lapidarius* of science. Its large size, black body and red tail, are sufficient to enable even those who take little notice of such things to know it when they meet it in the fields. Even in Shakespeare's time it would appear to have been differentiated from the other species. For when Bottom, in "A Midsummer Night's Dream," wished for a sip of honey, his command to Cobweb was, "Kill me a red-hipped humble bee on the top of a thistle."

And yet there is another bee so like it that it requires some practice in diagnosis to detect the difference. It is of the same size, and has also a black body with a red tail. Yet there are points of difference which enable the expert to detect the mimic at once. It does not, for example, go busily from flower to flower gathering honey to take home to the nest. It only wants an occasional sip for its own sustenance, and its idleness is quite apparent. The wings are darker than in the Bombus, there are no little baskets on the hind legs for collecting pollen, and there is a curious shining, almost bald patch on the upper surface of the abdomen. Had Monsieur Cobweb killed it in mistake for the red-hipped humble bee, he would have found no bag of honey. This bee belongs to a group very near the true humble bees, and sometimes known as parasitic humble bees. They have been placed in a different group and named Apathus, or Psithyrus. Noting the striking resemblance we say, in the language of modern zoölogy, here is a remarkable case of mimicry. And when we learn that the mimic is a parasite on the red-tailed humble bee, then, if we are believers in the theory, we say, "This resemblance enables the parasite to enter the nest of the host more readily. It has been acquired because those which possessed it in the highest degree succeeded best in deceiving the host, and so getting their young reared at its expense." Shuckard, in his work on "British Bees," writes of these parasites thus:—

"Both sexes appear to have free in- and egress to, the nests of those Bombi which they infest, without any let or hindrance on the part of the latter, with whom they seem to dwell in perfect amity."

The resemblance of the parasite in the case of the Red-tailed Humble Bee is certainly striking, and according to the above, perfectly succeeds in its purpose of deception. Yet one asks, Why should such a perfect resemblance fail in more than one important point? Why should this bald patch, and these dusky wings, betray it even to a somewhat casual observer? A little difference in the way of greater hairiness, or lighter colour in the wings, would have been so easy, and likely to occur as chance variations! And then it has, as Mr. Sladen says, "a distinctly lower-pitched and softer hum."

It gets its name Psithyrus, that is, "whispering," from this. If, then, it cannot quite deceive us, how can it deceive the owner of the nest in which it wishes to lay its eggs? And in the darkness of the nest where it probably first meets the owner, a resemblance depending largely on colour would be of little avail! Moreover, are we not told that bees recognise each other and strangers rather by *smell* than by sight?

Recent studies of the parasite and its host, however, compel us to change our point of view somewhat. For it does not appear to be the object of Psithyrus to slip unnoticed into the Bombus nest, and lay its eggs unobserved. According to the account given by Mr. Sladen in his recently published work, "The Humble Bee," it invades the nest rather to fight with and kill the lawful queen. The parasites, in fact, rely more on their "exceedingly thick and strong skin, covering them like a coat of mail and protecting them from the stings of the Bombi." Moreover, being idle, they are further protected by having no soft wax-yielding membrane between the dorsal segments, as have the humble-bees. The sting is also stouter, and more curved. It does not appear, then, that the resemblance can be of any advantage to the parasite, or that it can deceive the humble-bee. Psithyrus, in fact, neither requires nor makes use of its remarkable resemblance.

Let us suppose, however, for a moment that the resemblance were perfect, and that the Bombus queen took the invader for another queen of her own kind. What would happen? We turn to Mr. Sladen's book, "The Humble-bee," for an answer. Some of the later-appearing individual queens of the Red-tailed Humble-bee do not take the trouble to start nests of their own, but enter those of others to lay their eggs. At first the stranger is ignored, but soon jealousy arises, and there is a mortal duel. One of the queens is killed, generally, says Mr. Sladen, the intruder. Thus the advantage to the parasite of being like the host is more than doubtful.

Again, the Humble-bee shows by its different behaviour that it recognises the parasite. "The Bombus queen," writes Mr. Sladen, "on first meeting the Psithyrus in her nest, shows a certain amount of agitation and may advance to attack her, but her courage failing she draws back." Evidently the resemblance does not deceive her. And if it be true that bees usually recognise each other by scent, and that they can in this way detect one of their own species from a different nest, we need not be surprised at this, however perfect the outward resemblance. The first alarm of the Bombus queen at the presence of Psithyrus is followed by a "kind of despondency," and her interest and pleasure in her brood seem less. In the course of time there is a fight, and the parasite generally wins, sometimes killing several workers which have come to the assistance of their mother, as well as the Bombus queen.

In the face of all these facts what becomes of the theory that the mimicry of Psithyrus is protective, and has been acquired as a useful character by natural selection? The resemblance does *not* deceive the host, and it would apparently be *no advantage* to Psithyrus if it did.

The resemblance, as Mr. Sladen tells us, is not merely superficial, as in the case of bee-like flies. Psithyrus is almost a Bombus in general structure. And this suggests a close relationship, as if the Psithyrus had been a Bombus which took to parasitism—as individuals of certain species do to-day. Thus, individual queens of the Red-tailed Humble-bee, will, as we have seen, enter the nests of others to lay their eggs. And, if this is so, then it is the points of *difference* that have to be evolved, and not the points of *resemblance*.

Having disposed of the Bombus queen, Psithyrus reigns in her stead. She lays her eggs, utilising the wax she finds in the nest, since she cannot make any of her own. Her young are tended and fed by the Bombus workers. Apparently, as a sort of protest against the usurper, the latter begin to lay eggs, though these would only produce males. The usurping queen, in her turn, eats them! It is obviously her interest to do so, for thus the workers will devote all their time to the rearing of the young parasites.

And a very curious problem is suggested by the fact that the young of the Psithyrus queen are reared by the Bombus workers. For there are no workers among the parasites as there are among the Bombi. And the difference between these workers or neuters and the queens among the Humble-bees is believed to be the result of diet. The workers must settle which are to be queens and which neuter. If a given grub is to become a queen, it must from a very early age be fed with a richer diet. Yet the Psithyrus female grubs all turn out queens! Are they all fed on the royal diet, or are they all fed on the more meagre diet which some superiority of constitution enables them to turn to better account than would the grubs of Bombus? In either case it is curious that the Bombus workers should not make a difference, feeding some for queens and some for workers, as they would in the case of their own kind. And it would obviously be to the interests of the Red-tailed Humble-bee as a species if the Psithyrus grubs were all fed on so meagre a diet that they all turned out neuters. On the other hand, the feeding of *all* on royal diet might be a last effort at self-preservation—a vaulting ambition which overleaps itself and falls, on the part of Bombus. For might not *one* of the grubs fed royally turn out a Bombus queen? But the only result would be the full complement of Psithyrus queens. If, however, they thought to destroy the parasite race by rearing neuters instead of queens then the superior constitution of Psithyrus, thriving on the more meagre worker diet, developed the queenly character in spite of their efforts.

THE POWER OF CONTACT.

By CHARLES E. BENHAM.

OVER a hundred years ago a memorable discovery was announced by Volta, who claimed to have proved that by the mere contact of a disc of copper with a similar disc of zinc the two metals became electrified, the copper negatively, the zinc positively. Much dispute arose over the experiment: for though Volta repeated it hundreds of times, always with just the same result, many men of science would not believe in it. It seemed to oppose the fundamental doctrine of the conservation of energy and to suggest the heresy of perpetual motion; and so the "contact theory" of electricity was rejected on the principle that "it can't be; therefore it isn't." It seems strange that instead of arguing as to whether it was possible or not, the scientific world did not try the experiment for itself. It was an exceedingly simple one, one that anybody can try with a condensing electroscope, and one that never fails to verify exactly what Volta announced. But instead of putting the matter to a practical test, the learned world, feeling quite convinced that there must be a mistake somewhere, contented itself with abandoning the contact theory as impossible, and for a long time it remained universally discredited in spite of the fact that anybody could have easily demonstrated its truth at any time. At last came Lord Kelvin, who took the wiser course of repeating Volta's experiment. He did it in a new and ingenious way, which avoided all possibility of any other cause than mere contact coming into action, and to his own astonishment, and that of the whole scientific world, he found that Volta was perfectly right. The discovery led him on to make other tests, all of which completely confirmed the mysterious and inexplicable fact that when one metal touches another, a separation of electricities occurs, one becoming positively charged, the other negatively. Copper filings passing through a zinc funnel are each in turn brought into contact with the zinc, and the falling stream gives up to the vessel that receives it a constantly accumulating charge of electricity. This is but one special case of a widely extending law, and it seems probable that any two dissimilar substances when brought into contact and separated, are charged with opposite electricities. What is called frictional electricity is another particular case of the same law. When a piece of sealing wax is electrified by rubbing it with flannel it is not the force of friction that is converted into electrical energy. The rubbing is only the means by which two such non-conducting bodies are brought sufficiently into contact to produce the effect. It is for this reason that frictional electric machines involve such a wasteful expenditure of force. An overwhelming proportion of the energy used is merely wasted so far as the direct production of electricity is concerned. The electrical output is only equivalent in energy to the amount of force required to bring glass and rubber into contact and to separate them again. All the rest of the rubbing is labour spent in overcoming resistance to such intimate contact. The modern static machines, such as the Wimshurst, require no friction, but depend upon a different principle, the principle of multiplying an infinitesimal original charge by the process of induction. That original charge is derived from contact, either contact between a small metal brush and the tin sector on the glass disc, or it may be by the mere contact of that sector with air.

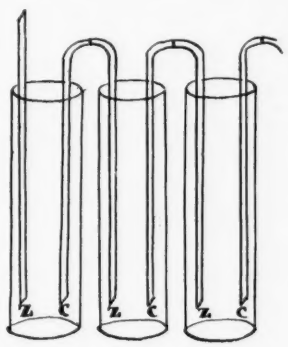


FIGURE 150.

According to Volta's principle the electricity of a battery of zinc and copper plates in acid water is due not to the chemical action of the acid on the plates but to their contact with each other, the acid water merely acting as a conductor to enable the current to pass. The chemical action is to be looked upon rather as the effect than as the cause of the electricity—an unfortunate effect, indeed, from one point of view, because the acid

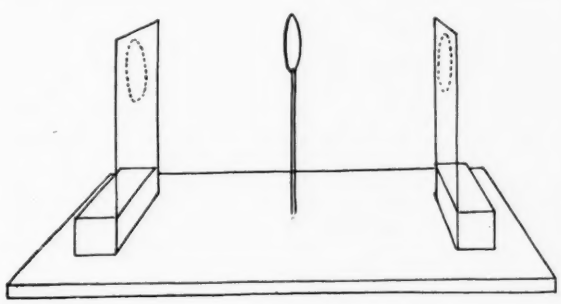


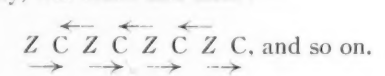
FIGURE 151.

necessarily acts upon the metals and so limits the life of the battery. Yet acid is necessary because without it water is not a good enough conductor for the current.

Whether Volta was strictly accurate in looking upon chemical action as the result rather than the cause of the electricity in a voltaic cell may be an open question, but certainly his explanation may be as good as the other, and it is noteworthy that it is sometimes instinctively adopted even by those who believe in the chemical theory; for it is usual to speak of the corrosion that takes place when zinc and copper are rivetted together as being due to electric action.

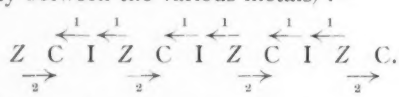
But what naturally will occur to anyone hearing of the suggestion that zinc and copper give electricity by mere contact and that the acid solution is a mere conductor which is only incidentally destructive of the plates, is the question, why should not the metals be used without the acid and a conducting way for the current be found by uniting the pairs of metals direct? In this way it would appear at first sight as though we could get a series of cells without any liquid conductor, and one, therefore, practically permanent.

A moment's consideration will, however, show that this is not practicable. If when zinc is joined to copper a current flows from the zinc to the copper, it is evident that by joining another pair a current will be established in the opposite direction. The following diagram, in which the arrows show the direction of flow of the current from contact electricity, will make this clear:—



The contacts obviously involve currents in the opposite direction which will neutralise the others.

Nor is any better result obtained if a wire of some other metal, say iron, is used to connect the pairs. In this case the effect is shown by the arrows in the following diagram (the numbers representing current intensity between the various metals):—



In fact the following law has been abundantly established:—When any number of metals are placed in contact in a series that returns to the metal it started with, there is always an equal development of contact electricity in each direction and consequently no flow of current either way.

However, it is said that Nature never locks a door without also providing a key. The key or clue to this problem consists in finding a uniting medium for the pairs of metals which is non-metallic, and at the same time free from chemical action, while sufficiently conductive to allow electricity to pass. Such a conductor is found in water. Its resistance without acid is high, but still it has some conducting power, while its contact electricity with the metals does not appear to be sufficiently appreciable to neutralise the flow. Reverting to our former diagram the series will now be

It is evident that in an extended series, there being a minute difference of electric potential between each pair, there will be a considerable potential difference between the extremities of the series.

The experiment may be made with a hundred test tubes in which copper and zinc soldered strips are placed in order. (See Figure 150).

If these are filled with pure distilled water practically no chemical action will occur, but the ends of the series will be in so high a degree charged with opposite electricities that the gold leaves of an electroscope will diverge widely when connected with either terminal. One end of the series will show a positive charge, the other a negative charge.

So far from this being due to any chemical action, it will be actually found that the potential difference is greater when distilled water is used than when acidulated water is placed in the tubes.

With a water battery of this form made of some thousands of tubes, Leyden jars may be charged and sparks of considerable intensity may be obtained.

The difficulties attending the construction of such a series and of insulating each tube perfectly are, however, very great, and when an extended series numbering thousands is required it is more convenient to resort to what is called the dry pile, though it is not strictly speaking quite dry; if it were it would not work.

The dry pile substitutes a connecting medium of ordinary paper for the distilled water, and so slight is the amount of moisture required for conduction that the small quantity of water always present in the pores of ordinary paper will suffice. For the metal plates it is unnecessary to cut out metal strips. Paper with a metal surface can be obtained ready made, either bronzed or tinned. Cut into squares or punch into circles a series of bronzed and tinned papers, keeping them in uniform order so as to have the arrangement—tin, paper, paper, bronze, tin, paper, paper, bronze, and so on, and the dry pile is made. The heap is firmly pressed together between two pieces of well-varnished glass for insulation, and close contact is maintained either by binding the whole round with tape or by gluing a strong band of brown paper round it. The terminals are strips of thin metal to which wires have been soldered. A series made up of twenty or thirty sections and well insulated will show undiminished electric activity for years. The energy will not be sufficient to give a spark, but the attractive power of the terminals will keep a small brass ball (suspended by a hair or fine silk) oscillating between two bell gongs without cessation year after year with no signs of exhaustion or enfeeblement.

A valuable practical application of the dry pile is found in an instrument for detecting minute

quantities of electricity. An insulated strip of gold leaf is suspended between plates connected with the terminals of a dry pile. The plates attract it equally, and, therefore, it remains at rest, but the most infinitesimal charge of electricity suffices to upset this equilibrium and to make the gold leaf sway to right or left according to the positive or negative nature of the charge applied. This form of electroscope is of extreme sensitiveness, and has the advantage of indicating the sign, positive or negative, of the electricity present.

While contact is the source of electrification the intensity of effect from a single contact is so infinitesimal that for practical purposes it is absolutely necessary to increase it. It has just been shown how this can be done by connecting in series a large number of contact-making plates, but this is not the only way in which an increased difference of potential can be brought about.

A second means is by applying the principle of nduction. When a charged body is brought near an insulated conductor without touching it, and the insulated conductor is momentarily earthed, it will be found to have acquired an induced charge nearly equal in amount to that of the inductor, though of opposite sign. And this happens without robbing the inductor of any of its electricity. In fact, by repeating the process any number of induced charges can be obtained without diminishing the electricity of the source. This obviously affords the clue to a way in which by a succession of induction processes an accumulated charge of appreciable magnitude can be obtained from even such an infinitesimal source as that of a pair of metal plates in contact. Adding together the induced charges they mount up to an unlimited extent.

But this process of repeated additions is necessarily slow. Much more rapid is the increase if instead of merely adding them they can be multiplied. Two induced charges, when combined, are practically double the inductor's charge. Two induced charges derived from this double charge will, of course, give a fourfold charge. Two from this will give an eightfold charge, and so on. The rapidity of accumulation on this doubling principle is astounding. Double a charge and its products in this compound interest way twenty-four times, and it increases more than eight million-fold.

A very simple and pretty experiment will illustrate this. Fix upright from the centre of a board a disc of metal supported by a narrow insulating strip of varnished glass. Provide two strips of similar varnished glass a little wider than the disc's diameter and in height not quite as tall as the top of the disc, and let them have discs of tinfoil attached near the upper part. The lower end of each is glued to a block of wood, so that they can be pushed along the board up to the inductor, one on each side, the tinfoil being on the outer side of the glass, *i.e.*, away from the inductor. The arrangement is shown in Figure 151.

The inductor, presumably by its mere contact with the air, has an infinitesimal charge of electricity, and this, solely by multiplied induced charges, can be made to give out in a few minutes sparks half an inch long. The effect is almost miraculous to the uninitiated, as the electricity seems to come from nothing. It really comes, not from nothing, but from an imperceptible and infinitesimal beginning.

The *modus operandi* is as follows:—Push one of the mounted strips close up to the inductor. Earth its sector by touching it with the finger. It has received an infinitesimal charge by induction, equivalent to that of the inductor. Slide it away and do the same with the second glass strip. Now bring both up to the inductor and touch the top of its disc. It will, of course, receive by induction from the combined influence of the two strips a double charge. Repeat the cycle and it will gain a fourfold charge. Repeat the process twenty-four times and the original charge will have increased some eight million times, and by this time at each earthing a growing spark will be heard and seen, and its intensity will go on accumulating until it is limited by the capacity of the three conducting discs.

This simple experiment illustrates very graphically the underlying principle of practically every form of electric influence machine, such as the Voss, the Wimshurst, and Clarke's gas lighter. All these machines merely provide for the rapid performance of a cycle of inductions so arranged as to produce an accumulation on the compound interest principle. The original source of the electricity is always the infinitesimal contact charge, generally that derived from the mere contact of air with the tinfoil sectors of the machine.

Lord Kelvin applied the same principle to a water-dropping apparatus in which two streams of water drops pass through the middle of cylindrical metal inductors, each drop carrying an induced charge as it breaks away from the stream under the influence of the cylinder. The drops give up their charges to metal cups which by means of cross wires communicate the growing charges to the inductors. Starting with no appreciable trace of electricity the accumulation rapidly multiplies and causes the startling phenomenon of flashing sparks between contiguous parts of the apparatus, and the accumulation is only limited by the fact that the streams of drops become so highly charged that they soon repel each other with such force that they scatter instead of falling into their respective receivers.

The same effect may be produced with two falling streams of sand or metal filings. In every such case the initial charge is derived from contact, and its manifestation is due to the doubling principle already explained.

In a very rough and general way it is possible to estimate the voltage of the original infinitesimal charge of a doubler. Reverting, for example, to our preliminary experiment with the strips of glass, it will generally be found that about twenty-four doublings yield a half-inch spark. It may be taken that every tenth of an inch represents roughly a

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potential difference of ten thousand volts, so that half an inch means fifty thousand volts. Now, the twenty-four doublings represent an increase of eight million times, so that the original charge may be put at about one eight-millionth of this, or the one hundred and sixtieth part of a volt. At the same time the amperage, it must be remembered, is, even in the case of the fifty thousand volts, practically unappreciable, so that the high voltage obtained does not mean practical efficiency, say for lighting or power purposes.

These few experimental illustrations all demonstrate the mysterious principle of the origin of electricity from contact. They do not, however, demonstrate how or why electricity originates from contact. Here we come to the boundary line between the known and the unknowable as far as physical science is concerned. The rest eludes our senses. We come, as it were, to the horizon line of the phenomenal, beyond which lies the noumenal that is not attainable by the material senses.

All that can be said is that it seems as if the law of contact was in the case of electricity merely a particular case of the operation phenomenally of some very vast law that also makes itself manifest in many other ways. The mystery that peeps out in contact electricity may in the noumenal world be one with the mystery that eludes us when we seek for the cause of many potent influences arising from contact in quite other departments of human observation, not only in chemistry and other material sciences but in purely human energies. The power of "the touch of a vanished hand" may be as truly due to polar sympathies as the force that arises from the contact of dead zinc and copper. And in the great unity of things which it is beyond us to grasp the hidden cause of each may be one and the same. It may be that there was no mere playful conceit, but a hint of profound truth, in those pretty impromptu lines with which Dr. Herbert Mayo celebrated the epoch-making discovery by Faraday of electro-magnetism :—

"Around the magnet Faraday
Was sure that Volta's lightnings play,
But how to draw them from the wire?
He took a lesson from the heart:
'Tis when we meet, 'tis when we part
Breaks forth the electric fire."

THE HORNET AS A PET.

By G. HURLSTONE HARDY.

I BEGAN to be interested in *Vespa crabo*, with the appearance of which I was much impressed, in my early youth. It then happened that I acquired a large triple observation hive, but no honey bees. I had to be content with placing therein the nests of several kinds of wild bees, of course, separately, and studied their habits and those of their parasitic enemies.

One summer, when I had in hand two colonies of the large common bumble bee, and was hopeless of acquiring hornets, I determined to add wasps. With the assistance of two schoolfellows I smoked and dug out a nest of three horizontal combs. These we placed in the central hive, with a few young wasps and the queen wasp. These young wasps had very recently emerged, and could hardly yet fly; however, they cleaned and fed the young in the combs. We fed them with jam, house flies, and other insects. In about one week a sufficient brood of newly-hatched working wasps were able to forage abroad and rear all the brood. Unfortunately, the queen disappeared, and the community did not increase to the normal size of a full autumnal brood. The most curious fact observed was that certain lazy wasps made a habit of awaiting at the alighting boards of their bumble bee neighbours, and there beg to be fed. They never threatened the bumble bees, who seemed willingly to feed them without realising that they were fatally neglecting their own broods.

My wasps never entered the nests of the bumble bees, and they did not resent being closely observed as long so the hive was not shaken and was only approached from behind.

Many years later I observed hornets flying very late in the summer evening about trees in Chiswick, but it was some time afterwards, whilst I was casually walking down Chiswick Lane, that I discovered hornets busy around four straw hives in the front garden of a cottage. I entered and asked the proprietor to let me observe them. I found that he kept these hornets for pets, and that he had no bees. We had a long conversation on hornets and again on another occasion, but I regret that circumstances prevented my visiting the locality for several years. When I did eventually go there, my acquaintance was not to be found. I hoped to establish colonies like his in my own garden at Twickenham, but have never been able to do so.

I learned from my acquaintance much of great interest, and I was confirmed in all my somewhat conjectural ideas about the habits of hornets which vary much from those of their cousins, the commoner wasps. Friends are apt to accuse me of joking when I aver that the hornet is a gentle, inoffensive creature very suitable for a pet; but it really is so, and the reason is easily explained. Accustomed to hunt high in the tree tops she remains ignorant of the savagery of the average school-boy and she seldom experiences the malice of man or becomes aware of the trepidation of woman at the mere sight of a wasp. Her services must be overwhelmingly beneficial in woods and orchards. At midsummer she forages much in the night. The honey bee gathers from sunrise to sunset but works hardest in the forenoon and slackens towards evening. The wasp begins an hour earlier and ends an hour later. Now hornets work throughout most of the twenty-four hours if the weather permits. When I visited my acquaintance in Chiswick Lane he had two hives occupied by numerous inhabitants and one other by a very young colony; he lifted up the latter hive and let me observe the queen at work. He said he felt no danger whatever, although she was at that date being assisted by her first brood of workers. I greatly desired to know how he managed to have inhabitants for his hives year after year, inasmuch as hornet colonies were reputed to be not like those of honey bees, but like those of wasps, started anew each year singly in a new spot by a surviving queen after hibernation. He said that every year, since he had started with a transplanted colony, queens had voluntarily chosen hives in his garden.

Having lost such a unique opportunity of learning more, I regret that now I can only surmise that queen hornets either hibernate in the old nest or inherit an inclination to frequent the locality of their birth, habits which are both contrary to those of the common wasps and bumble bees, though the upholsterer bees and their nearest relatives do exhibit an excessive attachment to the spot from which they emerge.

If ever I succeed in getting a colony of hornets, I shall install them near the top of my house rather than near the front door steps on the ground, as did my acquaintance. I have no fear whatever of these innocent and useful creatures, who seem quite willing to share our dwellings with us if encouraged to do so, but a high elevation would suit their habit of high flight.

EARTHQUAKES FROM A JAPANESE POINT OF VIEW.

By BLACKFORD LAWSON.

Member of the Japan Society.

No other country in the world probably affords such facilities for the study of earthquakes as Japan, nor is there anywhere else such necessity for their scientific investigation.

Nearly one thousand four hundred of these phenomena are recorded annually in the whole of the Empire, and in Tokyo alone there are, on an average, fifty earthquakes that can be felt during the year, or about one a week. Earthquakes, as every one knows, occur in all regions adjacent to active volcanoes, as in the neighbourhood of Teneriffe, Vesuvius, Etna, and Stromboli, which are simply the safety-valves of a single earthquake district. So also Japan, Sumatra, Java, and the islands of the East Indian Archipelago are liable to fearful earthquakes; and geologists say that much of Japan would never have existed but for the seismic and volcanic agency which has elevated whole tracts above the ocean by means of repeated eruptions.

FIGURE 152. Earthquake Crack three feet wide, made during the great earthquake in the Yamogata prefecture (North Japan).

It is, therefore, only to be expected that it occupies an unique position in the world as regards seismology. Consequently, there is a special Chair of Seismology and an Institute attached to it in the University of Tokyo, and also a special committee for the investigation of earthquakes, under the direct control of the Minister of Education. Besides this, all the provincial meteorological stations throughout Japan are equipped with instruments for recording and measuring earthquakes, and seismic phenomena are systematically studied.

In the interior, the writer frequently met, in an out-of-the-way cave or on the mountain-side, members of the Seismological Society of Japan, originally organised by Professor Milne, who, with their delicate instruments set up, were mapping down every quiver of the earth's crust.

A study of a map of the world will show that the configuration of earthquake centres, as seen in India, Japan, Java and Sumatra, is that of an arc, and that in each case the earthquake region lies on the outer or convex side of the arc, where the deformation of the earth's crust seen in the curvilinear form of the arc shows that the strain is greatest. Thus, in the Himalayas, severe earthquakes take place on the outer or steep side, rather than on the concave or Tibetan side; and in the case of the Japan arc, great seismic disturbances occur almost always on the outer or Pacific side, where the Pacific Ocean forms the greatest area of depression in the world, and only small local shocks originate on the inner or Japan Sea side of the arc.

After the great catastrophe in North-West India on April 4th, 1905, the Japanese Government, ever eager to study earthquake phenomena at first hand, sent their leading seismic expert, Dr. F. Omori, Professor of Seismology at the Imperial University, Tokyo (see Figure 157) to investigate and report on the nature of the disaster. During several months' stay in Tokyo, the writer was honoured by the friendship of this eminent man, and spent many delightful hours in his lecture-rooms at the University, and also with his charming family in their picturesque home. From Professor Omori, she learnt that the appalling loss of life in Dharmsala and the Kangra Valley was due to faulty construction, the houses being built of stones roughly piled together without any good cementing material, and surmounted by a heavy roof.

In construction the first point is to make the foundation solid and as large as possible, because, if weak, cracks will be produced. In two-storyed buildings, the upper storey suffers more than the

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lower ones, the vibration being greater at a height than at the base. Again, a structure may be very heavy, but if built of bad material it can have no

FIGURE 153. The Earthquake-proof Building erected in the grounds of the Imperial University, Tokyo.

resisting power, and it will simply "smash down," for good material and good construction are more important than thickness of walls. Now, in the Punjab the houses were built solidly enough, the walls being two feet thick, but they were filled up with rubble and small stones, and were, therefore, bad from an earthquake point of view.

Professor Omori speaks very decidedly with regard to the responsibility of Government in the erection of jails and barracks, and he used a stronger expression than the writer ever heard before on the lips of a Japanese in criticising Occidental methods, when he said, in conclusion: "It is *almost criminal* on the part of the Government to build bad structures for public purposes, such as schools, jails and barracks, and my advice to the Indian Government would be to build more substantially, always on a sure foundation, with good binding either of wood or iron, and to use good material, especially in the case of public buildings."

In Calcutta, Professor Omori found that the theory of the engineers was, that the soft soil of Calcutta acted as an elastic cushion, and, by absorbing the earthquake motion, prevented it from being communicated to structures standing upon it. Now this was quite an erroneous idea, earthquake motion being invariably felt more in soft than hard ground; and even within the confines of the city of Tokyo a shock varies considerably, one in the upper part being one-half less in intensity than it is in the lower and softer parts. The same fact was also made evident in San Francisco, where at the time of the earthquake "made ground" and soft land suffered more than the hard.

Speaking generally, the most important principle in construction is to make the structure *a single body*, simple and compact, avoiding the possibility of different parts assuming different movements or vibrations. For example, chimneys are dangerous, because a chimney vibrates differently from the main building, and in the event of earthquake it will be found that a chimney is always broken at its junction with the roof; so that, as the fracture of a brick column occurs at a joint, its seismic stability ought to be increased by using good mortar, until the strength of the joint becomes equal to that of the bricks themselves. In 1894 a curious earthquake occurred in Tokyo, during which several chimneys were knocked down in barracks, factories, and schools, killing many soldiers and others. To obviate this danger the Japanese now make the part above the roof of light material, such as sheet-iron, or better still, of earthenware (*dokwan*). As a matter of fact, Tokyo is rendered generally hideous by these iron chimneys—perfect abominations, which tower above the roof-line, and are, indeed, made so long that, when they fall, they do not crash through the roof, but topple over into the street or garden beyond.

In Japan, it is interesting to note that ancient castle walls, built several hundreds of years ago, have forms approximately equal to the curve theoretically giving the greatest stability against earthquake, known geometrically as the parabolic curve. We find that the walls of all old castles are made of parabolic section, thicker at the base, in the form which mathematically gives uniform strength throughout the height and prevents the formation of cracks; and, as a matter of fact, all these castles have withstood terrific shocks of earthquake.

There is no better example in the whole country than the walls of Nagoya Castle (see Figure 154), which are built of polygonal blocks, ten, twenty or

FIGURE 154. Nagoya Castle, one of the "sights of Japan." The walls are of parabolic sections, to give stability against earthquakes.

thirty feet long, uncemented, and fitted into the bank at an even slope; and yet, after hundreds of years of storm and earthquake, there is scarcely a

crack to be seen. They withstood the great earthquake in 1892, when thousands of houses fell in Nagoya and Gifu, and in the smaller places round about, and when all the new brick telegraph and post-offices and other European buildings came crashing down like ninepins. On that occasion, Japanese houses did not fall, unless they were old and frail, when in many cases the supports gave way and the roof came down, imprisoning the inmates until they were rescued, sometimes from a house in flames. The walls of the Castle of Tokyo show the same remarkable state of preservation, the blocks of cyclopean masonry, there also uncemented, being neither cracked nor displaced in the least degree.

Figure 153 represents an earthquake-proof structure erected in the grounds of the Imperial University, Tokyo, which has been built according to mathematical calculation on a solid concrete foundation, and is intended for use as a Seismological Observatory, and as a standard with which to compare the effects of a shock on ordinary brick buildings. In it most interesting investigations into the stability of various structures against earthquake shocks are carried on, artificial earthquake motion being produced by means of a "shaking table," which can be made to move with independent horizontal and vertical motions by the use of steam engines. (See Figure 158).

Another remarkable fact in Japan is that pagodas (see Figure 155), built hundreds of years ago embody the principle of the modern seismograph, which is

FIGURE 155. A typical Japanese Pagoda. It is a remarkable fact that these pagodas, built hundreds of years ago, embody the principle of the modern seismograph.

to minimise the effect of earthquake motion by the combination of an inverted pendulum with an ordinary pendulum; or, in other words, by the union of a stable and an unstable structure, to produce a neutral stability which renders the whole building least sensible to earthquake shock. In the

FIGURE 156. A Japanese bell-tower, wherein the suspended bell acts as a safeguard against earthquakes.

hollow well of every five-storeyed pagoda a heavy mass of timber is suspended freely, like an exaggerated tongue, from the top right to the ground, but not in contact with it, and at the shock of an earthquake this large pendulum slowly swings, the structure sways, and then settles back safely to its base. This is also the principle followed in the construction of all bell-towers throughout Japan, where the bell acts as pendulum, and the roof, supported by posts, forms an inverted pendulum, as in the seismograph. When an earthquake occurs, a pagoda or a bell-tower may be rotated or displaced, but it cannot be overturned as a whole.

Although seismologists have not yet succeeded in finding out any means of definitely predicting the occurrence of an earthquake, they are very hopeful of finally arriving at this desired goal; and already Professor Omori, with his deflectograph and vibration measurer, can discern danger by careful observation of the pulsations which are always gently agitating the surface of the earth, and can usually give ten or twelve hours' notice of a shock. A sudden cessation of the regular heart-beats or pulsations of the earth's crust is a danger signal, extreme stillness invariably preceding an earthquake, whereas constant tremors are a good sign.

A great earthquake is almost always followed by weaker ones, and when it is violent and destructive the number of minor shocks following it may amount to hundreds, or even thousands, and continue for several months or years. The occurrence of after-shocks is quite natural and necessary for the settling down into stable equili-

brium of the disturbed tract at the origin of disturbances, each of these shocks removing an unstable or weak point underneath. Further, as a very great shock would remove a correspondingly great underground instability, it is probable that such a shock would not, for a long time, be followed by another of a magnitude comparable to its own, in the same or a neighbouring district. When, however, the initial shock is not very great, it may be followed by another like it; but even in this case the position of the origin of the second shock would usually be quite distinct from that of the first.

It is a matter of common knowledge that a large part of the soil of Holland, with its villages and cities, is many feet below the level of the sea, and is slowly sinking, while the Scandinavian Peninsula is in process of elevation. It is in this way that the great changes in the earth's surface take place in the course of ages; and the theory that mountain ranges, like the Himalayas, were suddenly thrust up by some world-shaking upheaval, has long since been dissolved by the light of experience and investigation. But while these mighty changes have come about unseen and unheard, the petty shakings of the seismic regions force themselves in a terrible way upon our attention, as in the appalling disaster of 1909 in Calabria and Sicily, one of the most awful of the recorded earthquakes of the world.

Earthquakes are of such common occurrence in Japan that they are hardly noticed unless

FIGURE 157. Professor Omori with Vibrating Recorder at the Seismological Institute, Tokyo. By means of this instrument vibrations of railway bridges and steamers are measured.

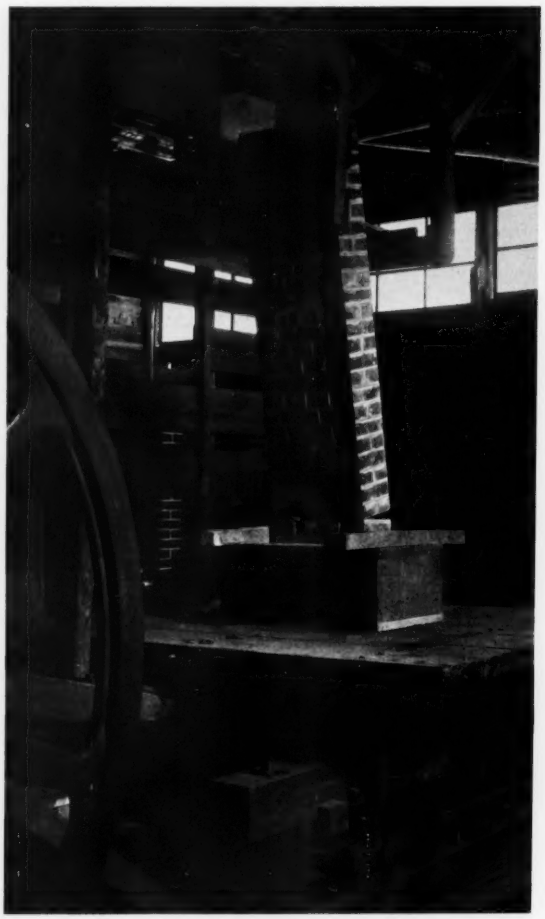

FIGURE 158. "Shaking Table" in the Seismological Institute, Tokyo University. The bricks are made specially for testing purposes from brick columns previously destroyed by earthquake. They are pulled asunder in order to find out the strength of the brick and mortar joint.

some damage is done, and the writer was often awakened in the night by the bed rocking from side to side, which sometimes caused a slight feeling of giddiness, like being at sea. She was also unpleasantly reminded of the forces at work at this seismic junction of the universe, when staying in the Yamogata Prefecture, in the north of the main island, where an unusually strong shock of earthquake was experienced. It lasted fully three and a half minutes, and although the house in which the writer was staying was not seriously damaged, there were cracks three feet wide in the ground near the windows (see Figure 152). The building rattled and swayed as though Samson were beneath shaking it as a terrier does a rat, the surprised dogs outside began to bark and the cocks to crow, and the feeling of mysterious tremor or palpitation was distinctly uncanny. At the first indication all the Japanese rushed frantically into the street shouting, "*Jishin! Jishin!*" (earthquake) and stood huddled together in the utmost terror until the danger seemed over. The writer's own instinct was to sit tight and cling to the writing-table, but presently she found herself sliding on the floor with pictures off the walls and bric-a-brac—ancient and modern—strewn around. In Tokyo people mention earthquakes as we in England do the weather, when other conversation fails, and thrilling tales of personal experiences during the most appalling of all the operations of nature, are often told round a dinner-table in the metropolis.

THE EXISTENCE OF AN ULTRA-NEPTUNIAN PLANET.

By PHILIP H. LING, M.Sc.

THE discoveries of the planets Uranus and Neptune were the first two steps in the outward extension of our knowledge of the solar system. The third step—the discovery of a planet still more distant—is yet to be made. There is, however, a considerable amount of evidence for the existence of such a planet, and in the present article it is proposed to give a short discussion of the arguments which have been brought forward.

It should be remarked at the outset, that visual observation will play no part in the argument; for it is almost certain that no planet exists of sufficiently large dimensions. We, therefore, have recourse to indirect methods by studying the effects which the hypothetical planet may be supposed to produce in bodies which are themselves capable of being observed.

(1) The most obvious way of doing this is by examining the perturbations of Neptune. Now the latter has a period of one hundred and sixty-five years and has only been under continuous observation since 1846—that is, for less than one half of its orbit. It is obvious that no certain conclusions can as yet be drawn from so small a portion of Neptune's path; and while the method may be useful centuries hence, it is at present too precarious.

(2) A more hopeful plan is to study the perturbations of Uranus. These are not completely explained by the attraction of Neptune, and have recently been examined almost simultaneously by Pickering* and by Gaillot,† working independently. They agree in the mean distance of the unknown planet, which is given as about fifty-two astronomical units; but Pickering finds the mass to be twice the mass of the earth, while Gaillot makes it five times: the latter also suggests a still more distant planet to be required. The smallness of the mass militates heavily against the correctness of the arguments since the effects produced must be infinitesimal.

(3) The best method of all is that derived from the orbits of comets. If we compile as complete a list as possible of the periodic comets, arranged in ascending order of period, a very striking fact becomes apparent. They are seen to fall into groups, the first of which contains those with periods ranging from 3·3 to nine years, the second those of period about thirteen, the third about thirty-three, the fourth about seventy-three, while there seems to be a fifth with period about one hundred and twenty-one years. Now each of these groups contains comets whose aphelia are approximately at the same distance as one of the planets Jupiter, Saturn, Uranus, and Neptune, while the fifth group seems to correspond to a hitherto unknown planet. There is, therefore, apparently some connection between these groups of comets and the corresponding planet, and before basing any argument on it, it is necessary to inquire more closely into the nature of the relation.

Now the most obvious explanation of the relation between comets and planets, is that known as the "capture" theory. According to this, at some previous era the comet approached so closely to the planet, that the gravitational attraction of the latter was sufficient to overpower that of the sun, but not large enough to transform the comet into a satellite. The orbit thus became a long ellipse, with one focus in the sun and the other in the position temporarily occupied by the planet; and this orbit would remain permanent in the absence of commensurability between the periods.

This appears to afford an explanation; but two difficulties, mentioned by Newcomb‡, arise. In the first place, Encke's comet has its orbit completely within that of Jupiter, and no close approach occurs; but we know that this comet probably passes through a resisting medium, which is altering the major axis, and it has been shown by Backlund§ that "capture" within the last five thousand seven hundred years is not by any means impossible.

The second difficulty is extremely serious. The planets all move nearly in the same plane; the orbits of comets, however, are inclined to this plane at all angles, and, as a result, though the statement

* See *Nature*, June 17th and August 26th, 1909.

† *Comptes Rendus*, March, 1909. See *Nature*, July 8th, 1909.

‡ "Encyclopaedia Britannica," 11th edition, Art. "Comet."

§ *Royal Astronomical Society, Monthly Notices*, LXX, 5, (March, 1910).

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as to the aphelion distance above is still true, there is, in point of fact, no close approach at all. This is exemplified by Halley's comet, which, having its orbit inclined to the ecliptic at about 18°, never passes near the path of Neptune, to whose group it belongs.

In discussing the difficulty, we must remark that for "capture" to take place, it is only necessary that the aphelion focus should be in the plane of the ecliptic. Since this is not the case, there must have been a secular rotation of the major axis, which had moved the aphelion from its original position. If this rotation does not exist, then the "capture" theory must be abandoned. This applies to the more distant comets, for Jupiter's group is generally acknowledged to have been "captured," and in its case the inclination is usually small.

It is interesting to notice in the orbit of Halley's comet (the only distant comet which has been very thoroughly investigated) there was a divergence of two days in 1910 between the actual and calculated times of perihelion passage, so that an unexplained rotation of the major axis certainly exists. This is not to be referred to any known mass in the solar system, while an unknown mass must necessarily be very considerably out of the plane of the ecliptic to produce the observed results.

At this point, much light is thrown on the subject by a remarkable paper by Pickering*, which has just appeared. If the translational motion of the solar system through space experiences any resistance from the ether, or from scattered matter, the effect will be most visible in the case of comets, owing to their small mass and large superficial area. The result will be, that the aphelia will fall behind and will tend to group themselves in a direction opposite to that of the sun's motion. Pickering shows that this actually takes place, and supposes that the divergences which are visible are to be attributed either to a motion of the absorbing medium, or to a curvature in the sun's path. Here, then, is the explanation of that secular motion of the major axis, which we have shown to be required by the "capture" theory; and the latter is, therefore, not inconsistent with the facts.

The assumption of a resisting medium naturally raises some suspicion, for there is a danger of using it as a *deus ex machina*, in the way of solving astronomical difficulties. But it certainly exists in the shape of meteoritic swarms, even if the ether be itself non-resisting, and it is now fairly certain that the cause of the anomalous motion of Encke's comet is to be found in this direction. We may, therefore, conclude that if a group of comets exists outside that of Neptune, it is *a priori* evidence for the existence of a more distant planet.

Now, unfortunately, the evidence is rather meagre. Grignell† examined twenty comets, and deduced a planet at a mean distance of 50·61; but the periods of the comets are very far from certain. Comet 1862 III (related to the Perseid meteors) is supposed to have a period of one hundred and twenty-one years; while there has been stated an identity between the comets of 1532 and 1661. In 1911 it was pointed out that there was a distinct similarity between the Kiess and Quénisset comets of that year and comets 1790 I and III respectively. If this could have been established, there would have been much stronger evidence for the hypothetical planet; but in each case the differences were such as to lead to the conclusion that the similarity was merely fortuitous. It is necessary, therefore, to search for comets whose periods can be irrefragably shown to be in the neighbourhood of one hundred and twenty-one years, *i.e.*, they must be seen at two apparitions at least.

There have been one or two other investigations concerning unknown planets. Pickering‡ stated in 1910 that the orbits of comets and a certain perturbation of Neptune could be explained by the existence of a large and very distant dark body in a direction perpendicular to the ecliptic. Another interesting suggestion is that of Professor Forbes§, who gives some evidence for supposing that the comet of 1556 was split into three in aphelion, about the year 1702, by an ultra-Neptunian planet at the the great distance of eighty-seven units.

The conclusion reached in this paper is, therefore, that the orbits of comets present the most hopeful method of arriving at the unknown planet, their results agreeing roughly, as to the mean distance, with those derived from the perturbations of Uranus. The "capture" theory is, however, only rough; and for a proper treatment it will be necessary to discuss in general the motion of a comet under the combined attraction of the sun and a planet. These "parabolic orbits," as they may be called (since, for a small disturbing mass, they are approximately parabolas), present enormous mathematical difficulties, even compared with the case of orbits nearly circular. In the lunar theory, a revolution was effected by the suggestion of G. W. Hill, to treat the question as a particular case of the problem of three bodies and to solve by series. The parabolic case is complicated by the non-convergence of any proposed series, and practically nothing has been done in the way of mathematical analysis. Nevertheless, it seems to be a necessary step in the establishment of the existence of the unknown planet.

* "The Motion of the Solar System relatively to the Interstellar Absorbing Medium," *Monthly Notices, Roy. Astr. Soc.* LXXII. (1912, Suppl. No.)

† See *Nature*, October, 1902.

‡ See *Science Abstracts*, February 25th, 1911.

§ *Monthly Notices, Roy. Astr. Soc.*, December, 1908.

BIRD-CALLING.

By W. A. NICHOLSON.

THE art of attracting wild birds is one little known or understood except by those whose special interest lies in this direction. The bird-catchers, and those who trade in live birds, understand little, if anything, about this subject, and even the bird-catchers themselves seldom practise it, relying almost solely upon the live decoys shut up in small cages wherewith to attract their wild companions to the deadly limed twigs. One must be well versed and possess a thorough knowledge of the notes emitted by birds, besides being acquainted with their habits, before he can employ the aid of calls with success, and the professional bird-catcher is an individual of too indolent a character for this work, which, doubtless, is the principal reason he leaves it severely alone. Those who use bird-calls regularly are the bird-photographer, the field naturalist and the wild-fowler, and all with the one object and main purpose of decoying the species and making them come nearer, the first, to enable him to secure a good negative and larger picture; the second, to extend his knowledge of the habits of a species; and the third to secure the specimen. The wild-fowler, however, makes use of few calls, often not more than six, these usually being those imitating the cry of the wild duck (mallard) (see Figure 167), curlew (see Figure 164), golden plover (see Figure 163), green plover, (see Figure 165), wigeon and teal (see Figures 161, 162 and 171), and often two only are regularly carried, these being the calls of the golden plover and curlew. As will be observed from the illustrations which have been reproduced from photographs of various patterns in my possession, that I make use of regularly, there is quite a collection of different kinds, a total of eighteen being here represented. They are all of Continental manufacture, but may be purchased in England from Messrs. Spratt's Patents, Ltd., 24, Fenchurch Street, London, E.C.; they are by no means expensive in comparison to the pleasure to be enjoyed by their use, and cost from ninepence to three shillings and sixpence each according to make and finish. It is at all times advisable to procure the very best that are made, for the simple reason that with care they give the finest results and will last for many years. As remarked above, the successful use of these calls chiefly depends upon the operator and his practical knowledge of the proper notes emitted by the birds

FIGURE 159. Pheasant.

FIGURE 160. Woodpigeon.

FIGURE 161. Wigeon.

FIGURE 162. Wigeon (improved pattern).

FIGURE 163. Golden Plover.

FIGURE 164. Curlew.

FIGURE 165. Green Plover (Lapwing).

FIGURE 166. Owl.

FIGURE 167. Wild Duck.

FIGURE 168. Hare.

FIGURE 169. Hare. (another pattern).

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in a wild state, and without experience of the latter it will be only time wasted to endeavour to manipulate them, except, perhaps, with the exception of two of the instruments, namely, that of the woodpigeon (see Figure 160) and the golden plover (see Figure 163). These two are the simplest to operate and little practice is necessary to enable one to make successful use of them. The woodpigeon call may also be substituted for that of the cuckoo, and a little practice with it soon enables one to acquire the correct pitch and modulation of sound necessary. It is very interesting to visit a breeding haunt of the woodpigeon with one of these calls. My method is to conceal myself (I use a hiding tent for this purpose, which is furnished with tapes, to which I attach twigs, grass, and so on, and make use of the surrounding undergrowth to screen it) under the nesting trees, having previously arranged my camera in position, and send out a few notes. As generally happens, the cushats in the immediate neighbourhood are cooing all around, and, at first, little or no notice is taken by the birds of one's efforts, but the secret is to continue to call, not, however, uninterruptedly, but with pauses of about four minutes, making a fairly high pitch in the tone, when the birds will be observed to crane their necks downwards and stop cooing. Some bolder than others fly closer to the hidden caller, often approaching to within a few yards, and altogether the call, always assuming the proper sounds are given, has a most alluring effect on woodpigeons during the commencement of one of their breeding periods. During incubation, however, the birds pay little heed to artificial calls, and at such times it is useless trying to attract them. Another easily duped species is the cuckoo, which may be enticed to within a few feet of the manipulator, and the same may be mentioned of the golden plover (see Figure 163), partridge (see Figure 170), pheasant (see Figure 159), and little grebe (dabchick). Species somewhat more difficult to deal with are the wild duck (mallard) (see Figure 167), curlew (see Figure 164), snipe (see Figure 173), owl (see Figure 166), wigeon (see Figure 161), magpie (see Figure 174), oyster-catcher, and red-throated diver. All the calls illustrated should be worked with the left hand, so as to leave the right hand free for manipulating the shutter of the camera and other necessary items. The art of bird-calling is a most interesting study, possessing a peculiar charm, a charm impossible to describe, and one having a fondness for ornithological pursuits, and with plenty of time to spare, could hardly do better than take up so absorbing a hobby, the acquisition of which would repay him a thousandfold. But such a one must be possessed of great patience and perseverance, otherwise failure is certain.

FIGURE 170. Partridge.

FIGURE 171. Teal.

FIGURE 172. Blackbird.

FIGURE 173. Snipe.

FIGURE 174. Magpie.

FIGURE 175. Rabbit.

FIGURE 176. Jay.

THE ANNUAL CONFERENCE OF THE PARENTS' NATIONAL EDUCATIONAL UNION.

THE seventeenth Annual Conference of the Parents' National Educational Union will be held at Caxton Hall, Westminster, from May 5th to May 8th. The programme is now before us and bears at the top the motto "Knowledge the basis of National Strength." On the afternoon of the first day, Earl Beauchamp will preside and Mr. J. St. G. Heath will give an address on "Education and Social Sympathy." In the evening, a paper on "Self Education," by Miss C. M. Mason, will be read, and one on "How we teach Citizenship" by Miss L. Faunce, an ex-student of the House of Education, Ambleside.

Tuesday morning will be devoted to the consideration of the subjects taught in one of the Parents' Union Schools, and among the other papers of the day will be one on "Knowledge and Learning" by Mr. Stanley Leathes, C.B. The topics chosen for the third day include The Montessori System and some of the ideals of the Union. In the afternoon, with Dr. Parkin, C.M.G., as Chairman, Mr. J. L. Paton, High Master of Manchester Grammar School, will consider "Knowledge and its relation to National Efficiency," while the Earl of Aberdeen will preside in the evening, when the Bishop of Southwark will speak on "The School of Life."

Papers dealing with the administration of the Union will occupy the afternoon of Thursday, and in the evening there will be a meeting for children's nurses, when Dr. Flora Murray will talk about "Things that matter in the Nursery," and Miss Helen Webb, M.B., will consider "The Child as a Person."

There will be receptions on Monday afternoon and Tuesday evening. All particulars can be obtained from Miss E. A. Parish, 26, Victoria Street, S.W., but we may mention that season tickets, which admit to all proceedings, can be obtained at a cost of 3s. 6d. each (invitations to the receptions will be sent to holders of season tickets only), and day tickets for 1s. 6d. each.

WITHYWINDS AND WITHERSHINS.

By HARWOOD BRIERLEY.

AN exact definition of the two strange terms, withywinds and withershins, is not easily given. A withe, or withy, may be a flexible willow twig or osier, it may be a band of twisted rings, or the spiral coil of some plant-stem in the tangled hedgerow. The poet's woodbine itself, better known as the honeysuckle, is a typical winding withy, and, therefore, a withywind. We call to mind the fact that there are districts in which our great white convolvulus (*C. sepium*) is variously known as the hedgebell, bellbine, ropewind, and withywind. The latter vernacular name is as appropriate as any, for this plant's twisting stems are in some districts known as "devil's garters," which, like the stem of the woodbine, or honeysuckle, have been known to strangle a fox in the brake after dragging at its noose-like coils in a desperate attempt to extricate himself. The "withershins" or "widdershins" of Scottish literature is a compound of two Scandinavian or Gaelic words which have to do with coiling stems and the sun. Originally a provincialism, the term is now politely applied to some natural object which elects to turn round in a direction opposite to the sun.

Why do our weak-stemmed hedgerow plants turn spirally in totally different directions? The rule commonly obeyed has, of course, very few exceptions; and there is little doubt that every indigenous climbing-plant with corkscrew tendency travels like the hands of a watch, or follows the sun as closely as it can from east to west. Yet some long acclimatised species go the opposite way, while some species included in the same genus are quite antithetical in their feelings on the matter. This general habit of following the sun must surely depend on which hemisphere a plant's progenitors first acquired the instinct essential to its welfare, and it may have been governed by that same plant's desire to find either light or shade. Overnight our convolvuli, bindweeds, bryonies, tamuses, hopbines, and honeysuckles become partially rigid in sleep, and more supple again at sunrise, when they attempt again to follow the source of light around his orbit from the east to the far west of summer. It is reasonable to assume that a sun-loving plant which originated in the southern hemisphere would travel in an opposite direction, from right to left of the observer. Unsusceptible to the solar influence is the tender French bean, and the contrariwise spirals it makes proclaim it to be a withershin. If you unwind it from its stick or post and attempt to direct it aright, the snake-like growing-tip casts itself free to hang stupidly downward, and if the sap and cuticle have given this bine a fixed "set" it declines to resume its skyward journey, unless you place it in some of its former contortions. Although you wrap it round the stake in the direction it disdains, and tie it there at intervals, it will not cease to make erratic twists with new growth, until it can resume that eccentricity of climbing which was established fast in its nature, probably ages ago.

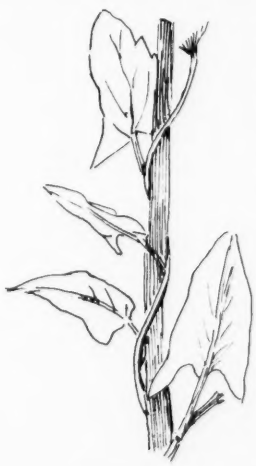

FIGURE 177.

Stem of *Convolvulus arvensis* twining to the left.

FIGURE 178.

Stem of Hop twining to the right.

Convolvulus sepium, the great white bindweed, may be called the typical withywind (see Figure 177), because of the fact that that name for it belongs to the vernacular of one or more southern counties. Although doubtless bearing the largest and handsomest of our white wild-flowers, which are bell-shaped and as pure white as foam, it is yet unfortunately an emblem of idleness in a garden lying waste, or it is at home on a high hedge which rarely suffers from the slasher. Like the cuscutas or leafless dodders worming their network of delicate pink stems among furze, thistles, and nettles, the numerous white bells hanging amid masses of lovely sagittate or arrow-shaped leaves which half smother the hedge afford some idea of the lianas which form such a striking feature of

tropical scenery. On a smaller scale we have the field-convolvulus (*C. arvensis*) with stem trailing along wayside banks and field-borders, embellished at intervals with pink and white-striped shallow almond-scented cups, or often clinging to wheat and barley stalks too tenaciously for any wind to unloose. It is remarkable to find that so many spiral climbing plants conform to the convolvulus type of leaf, all of them being withywinds if not withershins. The climbing polygonum or buckwheat—a common and detested garden weed—and the tamus or black bryony, with its glossy deep-green leaves, have little in common beyond their foliage, which features the convolvulus. This same black-rooted bryony (*Tamus communis*) and the red-berried bryony (*Bryonia dioica*) stand apart in other respects than foliage, but, even more than the vetches, they are both steadied by tendrils. The climbing buckwheat certainly makes good use of its small leaves to fasten it to a supporting plant. Its fine, traily, stringy stem, branching out in all directions, catches round stalks of corn, flowering plants, and foliage, twisting them all together in such a tangle that nobody could release them who had not more than human patience, all being finally borne down with the strain or weight. The convolvulus-like leaves are set singly at intervals, becoming very small towards the top, till they look like pygmean assegais. The growing tips are insinuated through narrow spaces before the topmost leaves open wide, whereupon the two broad lobes prevent any slipping back when wind-shaken or dragged at from beneath. From which it would appear that some species of plants make their leaves answer the purpose of tendrils.

Transgressing its own law and the usages of climbing plants in this hemisphere, we have known the bryony—both the black-rooted and the red-berried—commence its course aright, then halt, turn right round, and proceed from west to east in withershins fashion. We cannot conceive how such a plant comes to infringe the rule of the indigenes, but there may have been an obstacle in its path or some other equally good reason for its "striking out a new line." In fact, the bryonies are, even more than the bindweeds, now recognised to possess some of that inexplicable knowingness or sentience which brings them several stages nearer to the animal kingdom. Your fancy may be mesmeristic or your volition void, but your fingers can hardly cheat the bryony trailer out of its own perceptions exactly where a suitable support lies. Its sensitive leading tip squirms about here and there till it secures a suitable grip, and if, later, it comes to hesitate a moment, one may be sure that the unforeseen has happened, or recent conditions have changed, causing danger to lurk ahead. One wonders what particular sense enables the hopbine to repeatedly cross a three-feet space to its nearest support after as many forcible dissuasions by human fingers.

When the red-berried bryony gets enmeshed on a hedge one has some difficulty in determining which way its individual tendency is to travel. It may be hurtful to the hedge, which was planted originally to keep grazing cattle within bounds, but nature-lovers forgive its faults because of those wonderfully beautiful vine-like leaves which have been so sedulously copied by decorative wood-carvers from the earliest times of Art. The convolvulus type of foliage is wholly departed from, here being five fantastically cut, broad, vine-like lobes instead of the usual couple which terminate with tool-like point. Instead of a leafhold as with the climbing weed-like polygonum there are tendrils, some of which will stretch out for half a foot. When once they catch hold they become a corkscrew-like coil or spring which allows of sufficient "play" to escape damage.

I cannot say that I have ever seen any lonicera or honeysuckle play withershins. But a man once showed me a hazel walking-stick grooved out spirally when still young and tender by Lonicera's clinching hoop-like withywinds, which indicated this plant's indebtedness to the sun as an agreeable compelling-power. Here an individual plant had studiously distinguished itself by an eccentricity, or been compelled to fight for its own living in a novel manner, by taking a wrong or retrograde turn in life which led actually to fortune! The hazel, its host, is at first a sufferer, but, becoming a curiosity of value by reason of the startling spiral impression, gains immortality in the keeping of a collector of walking-sticks, not the least of whom was our late King Edward. Every conchologist knows the value of a very rare variety of shell whose whorls are termed sinister because they go the wrong way round, and long ages ago a shell of this pattern was supposed to bring luck to the finder or wearer, being in this respect not inferior to the swastika symbol or any other amulet. The sinister whorl of a shell and a withywind's withershins, grooved in a stick from the brake or copse, are corresponding freaks of Nature.

The wild and cultivated hopbine (see Figure 178) stands botanically apart from the honeysuckle, the two bryonies, and other climbing plants; but it is nevertheless a true withywind, capable of extending its growth by five inches a day. Although its scientific name, *Humulus lupulus*, appears to be based on a tradition of its being the "willow-wolf which lives in a rich damp soil," and although it is maligned as being able to strangle willows twenty feet or thirty feet high, we really venture to believe that the specific name "lupulus," is derived from lupulin, the active principle in hops. If it were a withershins to any great extent, we should certainly have some records from Kent.

THE FACE OF THE SKY FOR JUNE.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 31.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Jupiter. R.A.	Jupiter. Dec.	Uranus. R.A.	Uranus. Dec.	Ceres. R.A.	Ceres. Dec.	Pallas. R.A.	Pallas. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°
June 5	4 51·4	N.22·5	5 26·9	N.28·2	5 9·7	N. 24·1	2 5·2	N.10·5	19 11·2	S.22·5	20 39·6	S.19·1	15 18·9	S.12·0	14 25·2	N25·4
,, 10	5 12·0	23·0	10 24·0	N.12·4	5 56·4	25·2	2 18·2	11·1	19 9·2	22·5	20 39·2	19·1	15 15·4	12·2	14 23·7	25·1
,, 15	5 32·8	23·3	14 38·6	S. 19·1	6 40·2	25·1	2 32·7	12·0	19 6·9	22·6	20 38·7	19·1	15 12·4	12·4	14 22·8	24·7
,, 20	5 53·6	23·4	19 27·0	S. 26·7	7 19·4	24·2	2 48·6	13·0	19 4·4	22·7	20 38·1	19·1	15 9·9	12·7	14 22·4	24·2
,, 25	6 14·3	23·4	23 21·8	S. 4·7	7 53·5	22·5	3 5·6	14·1	19 1·8	22·8	20 37·5	19·2	15 8·0	13·0	14 22·6	23·7
,, 30	6 35·1	N.23·2	3 9·1	N.21·9	8 22·2	N. 20·5	3 23·7	N.15·2	18 59·1	S.22·8	20 36·9	S.19·2	15 6·9	S.13·2	14 23·3	N25·1

TABLE 32.

Date.	Sun. P	Sun. B	Sun. L	Moon. P	Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2
Greenwich Noon.	°	°	°	°	°	°	°	°	h. m.	h. m.
June 5	−14·0	−0·0	121·5	− 2·8	−8·4	−1·6	180·0	224·4	7 5 *m*	3 44 *e*
,, 10	12·0	+0·6	55·3	+20·0	8·2	1·6	250·2	256·4	3 0 *e*	4 55 *m*
,, 15	9·9	1·2	349·1	+16·7	7·9	1·6	320·4	288·5	3 15 *m*	11 54 *e*
,, 20	7·7	1·8	282·9	− 8·0	7·7	1·6	30·6	320·5	9 0 *e*	1 5 *e*
,, 25	5·4	2·3	216·7	−21·7	7·4	1·6	100·8	352·6	9 15 *m*	2 16 *m*
,, 30	− 3·2	+2·9	150·6	−14·8	−7·1	−1·6	171·0	24·6	7 10 *m*	9 15 *e*

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Jupiter, L_1 refers to the equatorial zone; L_2 to the temperate zone; T_1, T_2 are the times of passage of the two zero meridians across the centre of the disc; to find intermediate passages apply multiples of $9^h\ 50\frac{1}{2}^m$, $9^h\ 55\frac{1}{2}^m$ respectively.

The letters *m*, *e*, stand for morning, evening. The day is taken as beginning at midnight.

THE SUN continues his Northward march till $1^h m$ on 22nd, when the Summer Solstice occurs. Sunrise during June changes from 3–51 to 3–49; sunset from 8–3 to 8–18. Its semi-diameter diminishes from 15′ 48″ to 15′ 45″. Outbreaks of spots in high latitudes should be watched for.

MERCURY is in superior conjunction with Sun at beginning of month, then an evening star, reaching East Elongation on July 7th. Illumination full on 1st, one-half on 30th. Semi-diameter increases from 2½″ to 3½″.

VENUS is a morning star, at greatest brilliancy at beginning of month, reaches West Elongation July 4th. 4½° South of Moon on 1st. Semi-diameter diminishes from 19″ to 12″. At beginning of month 0·3 of disc is illuminated, at end of month one-half. Being south of Sun, it is less well placed for Northern observers than it was as an evening star.

THE MOON.—New $4^d\ 7^h\ 57^m e$; First Quarter $11^d\ 4^h\ 37^m e$; Full $18^d\ 5^h\ 54^m e$; Last Quarter $26^d\ 5^h\ 41^m e$. Perigee $10^d\ 4^h m$, semi-diameter 16′ 12″. Apogee $25^d\ 3^h m$, semi-diameter 14′ 48″. Maximum Librations, 3^d 5° E, 6^d 7° S., 18^d 5° W., 18^d 7° N. The letters indicate the region of the Moon's limb brought into view by libration. E. W. are with reference to our sky, not as they would appear to an observer on the Moon.

TABLE 33. Occultations of stars by the Moon visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance. Mean Time.	Disappearance. Angle from N. to E.	Reappearance. Mean Time.	Reappearance. Angle from N. to E.
1913.			h. m.		h. m.	
June 12 ...	BAC 4200	6·2	8 55 *e*	109°	10 0 *e*	320°
,, 12 ..	BAC 4225	6 3	11 16 *e*	66	11 52 *e*	352
,, 13 ..	62 Virginis	6·7	10 7 *e*	73	—	—
,, 17 ...	BAC 5347	5·5	0 12 *m*	50	0 57 *m*	334
,, 17 ...	BAC 5737	6·7	10 16 *e*	80	—	—
,, 18 ...	γ^1 Sagittarii	var.	10 51 *e*	148	11 36 *e*	216
,, 20 ...	A Sagittarii	4·9	—	—	11 30 *e*	240

From New to Full disappearances take place at the Dark Limb, from Full to New reappearances.

MARS is a morning Star, but not yet well placed for observation.

CERES and PALLAS are well placed for observation. They are of magnitude 7 and 8 respectively.

JUPITER is a morning star. Polar semi-diameter, $21_2''$.

TABLE 34.

Day.	West.	East.	Day.	West.	East.
June 1		○ 3124	June 16	3 ⊙ 24	
,, 2	31	○ 42	,, 17	32 ○ 14	
,, 3	324	○ 1	,, 18	312 ○ 4	
,, 4	431	○ 2●	,, 19	4 ○ 12	3●
,, 5	4	○ 312	,, 20	412 ○ 3	
,, 6	4½	○ 3	,, 21	42 ○ 13	
,, 7	42	○ 13	,, 22	41 ○ 23	
,, 8	4	○ 32 1●	,, 23	43 ⊙ 2	
,, 9	431	○ 2	,, 24	432 ○ 1	
,, 10	324	○ 1	,, 25	4312 ○	
,, 11	31	○ 4 2●	,, 26	43 ○ 12	
,, 12		○ 3124	,, 27	1 ⊙ 3	4●
,, 13	12	○ 34	,, 28	2 ○ 143	
,, 14	2	○ 134	,, 29	1 ○ 234	
,, 15	1	○ 324	,, 30	3 ○ 124	

Satellite phenomena visible at Greenwich, $1^d\ 0^h\ 36^m m$ I. Oc. R.; $2^h\ 24^m m$ III. Tr. I., $2^h\ 27^m m$ III. Sh. E.; $2^d\ 2^h\ 32^m m$ IV. Tr. I., $2^h\ 39m^m$ II. Sh. I., $4^d\ 1^h\ 8^m m$ II. Oc. R.; $7^d\ 2^h\ 5^m m$ I. Sh. I., $2^h\ 45^m m$ I. Tr. I.; $7^d\ 11^h\ 27^m\ 11^s e$ I. Ec. D., $8^d\ 2^h\ 22^m m$ I. Oc. R., $3^h\ 15^m m$ III. Sh. I.; $8^d\ 10^h\ 51^m e$ I. Sh. E., $11^h\ 29^m e$ I. Tr. E.; $10^d\ 11^h\ 28^m\ 6^s e$ II. Ec. D.; $11^d\ 3^h\ 25^m m$ II. Oc. R.; $11^d\ 11^h\ 0^m e$ III. Oc. R.; $12^d\ 10^h\ 28^m e$ II. Tr. E., $15^d\ 1^h\ 21^m\ 14^s m$ I. Ec. D.; $15^d\ 10^h\ 27^m e$ I. Sh. I., $10^h\ 56^m e$ I. Tr. I.; $16^d\ 0^h\ 45^m m$ I. Sh. E. $1^h\ 14^m m$ I. Tr. E.; $16^d\ 10^h\ 33^m e$ I. Oc. R.; $18^d\ 2^h\ 2^m\ 57^s m$ II. Ec. D.; $18^d\ 9^h\ 30^m\ 48^s e$ III. Ec. D.; $19^d\ 2^h\ 20^m m$ III. Oc. R.; $19^d\ 9^h\ 54^m e$ II. Tr. I., $11^h\ 57^m e$ II. Sh. E.; $20^d\ 0^h\ 44^m m$ II. Tr. E.; $22^d\ 3^h\ 15^m\ 22^s m$ I. Ec. D.; $23^d\ 0^h\ 21^m m$ I. Sh. I., $0^h\ 40^m m$ I. Tr. I., $2^h\ 39^m m$ I. Sh. E., $2^h\ 58^m m$ I. Tr. E.; $23^d\ 9^h\ 43^m\ 59^s e$ I. Ec. D.; $24^d\ 0^h\ 17^m m$ I. Oc. R.; $24^d\ 9^h\ 7^m e$ I. Sh. E., $9^h\ 24^m e$ I. Tr. E.; $26^d\ 1^h\ 29^m\ 21^s m$ III. Ec. D.; $26^d\ 10^h\ 46^m\ 39^s e$ IV. Ec. D., $11^h\ 43^m e$ II. Sh. I.; $27^d\ 0^h\ 9^m m$ II. Tr. I., $2^h\ 33^m m$ II. Sh. E., $2^h\ 59^m m$ II. Tr. E., $3^h\ 30^m m$ IV. Oc. R.; $28^d\ 9^h\ 3^m e$ II. Oc. R.; $30^d\ 2^h\ 15^m m$ I. Sh. I., $2^h\ 23^m m$ I. Tr. I.; $30^d\ 11^h\ 38^m\ 13^s e$ I. Ec. D.

SATURN is invisible, having been in conjunction with the Sun on May 29th.

URANUS is a morning star, coming into a better position for observation.

NEPTUNE is too near the Sun for convenient observation.

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
	°	°	
May 30 to Aug.	333	+ 28	Swift, streaks.
,, June	280	+ 32	Swift.
,, to July	252	− 21	Slow, trains.
June to Aug.	310	+ 61	Swift, streaks.
,, to Sep.	335	+ 57	Swift.
,, to July	245	+ 64	Swift.
,, to Aug.	303	+ 24	Swift.

DOUBLE STARS AND CLUSTERS.—The tables of these given last year are again available, and readers are referred to the corresponding month of last year.

VARIABLE STARS.—Tables of these will be given each month; the range of R.A. will be made four hours, of which two hours will overlap with the following one. Thus the present list includes R.A. 14^h to 18^h, next month 16^h to 20^h, and so on.

TABLE 35. NON-ALGOL STARS.

Star.	Right Ascension.	Declination.	Magnitudes.	Period.	Date of Maximum.
	h. m.			d.	
U Urs. Min.	14 16	+67 °1	7·6 to 12	327	May 29.
S Bootis	14 18	+54 ·3	7·7 to 13	273	July 9.
R Camelop	14 24	+84 ·2	7·2 to 13	269·5	June 3.
R Bootis	14 33	+27 ·1	5·9 to 12	223·3	June 19.
RR Bootis	14 44	+39 ·7	8·0 to 13	196·5	May 18.
Y Librae	15 7	− 5 ·7	8·0 to 11·3	365	June 12.
RS Librae	15 19	−22 ·6	6·6 to 12	217	May 20.
RU Librae	15 28	−15 ·0	8 4 to 11	314	June 24.
X Coronae	15 46	+:6 ·5	8·4 to 13	246	May 13.
R Serpentis	15 47	+15 ·4	5·6 to 13	357	May 16.
RR Librae	15 51	−18 ·0	8·2 to 12·6	276·7	June 22.
Z Coronae	15 53	+29 ·5	8·9 to 14	245	May 20.
T Coronae	15 56	+26 ·2	Now 9·5		Nova Coronae
R Herculis	16 2	+18 ·6	8·0 to 14	317·7	June 23.
RR Herculis	16 2	+50 ·7	7·8 to 9·5	241	May 9.
U Serpentis	16 3	+10 ·2	8·3 to 14	237·2	July 15.
SX Herculis	16 4	+25 ·1	7·9 to 9·2	100·55	May 12.
W Coronae	16 13	+38 ·0	7·8 to 12	244	July 14.
V Ophiuchi	16 22	−12 ·2	6·9 to 10·8	302·5	Apr. 20.
R Draconis	16 33	+66 ·9	6·4 to 13	245·6	July 29.
Z Ophiuchi	17 15	+ 1 ·6	7·5 to 13	348	May 10.
T Draconis	17 55	+58 ·2	7·5 to 12	426	Aug. 9.
RY Herculis	17 56	+19 ·5	8·2 to 13	222·3	July 22.

NOTES.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

THE SIZES AND DISTANCES OF THE STARS.—There was an interesting paper on this subject, by the Astronomer Royal, at the March meeting of the Royal Astronomical Society. He dealt with the faint stars within 10° of the North Pole, as these were observed by Carrington, at Redhill, sixty years ago, and have been recently re-observed at Greenwich, so that their Proper Motions are well determined. While the Proper Motion of an individual star does not give us its distance, it is possible to obtain formulae giving the relation between proper motion and distance for groups of stars. The Astronomer Royal obtains a formula for star distribution that fits the data from observation very well. Extending his figures to the entire sky, he finds that there would be three hundred and twenty stars with parallaxes greater than a tenth of a second. The number with a parallax greater than a fifth of a second would be one eighth of this, or forty. It will be remembered that Mr. Eddington recently gave a list of seventeen stars with a parallax greater than one-fifth of a second; a few more have since been found, and it is likely that there are several stars with an equal parallax that have not yet been studied for the purpose, so that the two methods are in fair accordance. The Astronomer Royal finds that a large proportion of the stars discussed lie between parallax 0″·005 and 0″·0025, and that ninety-five per cent. of them are intrinsically brighter than the Sun. Mr. Eddington finds that in another region only one per cent. of the stars in the catalogue he used are fainter than the Sun. He points out that this does not mean that the Sun really occupies so insignificant a place in the stellar host, for if we consider the stars of large parallax, the Sun comes quite high up on the list as regards intrinsic lustre. But when we go out to great distances, the intrinsically faint stars become too faint to come into our catalogues at all, and only those of high lustre survive. At a distance whose parallax is one-hundredth of a second, the Sun would be of magnitude 10·3, which is about the faintest included by the Astronomer-Royal in his discussion; at greater distances only stars of great lustre are included, so that the catalogue is not a fair sample of all the stars really existing in remote space. Incidentally, the paper made a suggestion that a short name should be given to the distance corresponding to a parallax of one second; the term "Astron" was tentatively put forward, but Professor Turner expressed some apprehension that this might be taken to mean the astronomical unit of length, viz., the mean distance from the Earth to the Sun. It is certainly desirable to have a name both for this unit and for the other, but it will be well to have a little discussion before they are adopted. The Astronomer Royal urged that the "Astron" should be generally used for stellar distances instead of the Light-Year. In view of the large use of the Light-Year that is made in many treatises on Astronomy, it is fortunate that there is a simple relation between the two; one "Astron" is almost exactly three and a quarter Light-Years. The beginner may like to see how this number is found. Light takes 498·2 seconds to travel from Sun to Earth. The number of seconds in a year is $365\frac{1}{4} \times 24 \times 3{,}600$ or 31,557,600. Divide this by 498·2 we get 63,346 astronomical units in a Light-Year.* But there are 206,265 astronomical units in an "Astron," this being the number of seconds of arc in the unit of Circular Measure. The "Astron" comes out as 3·2561 Light-Years, but three and a quarter is near enough for all purposes. I think the question of suitable names for these two units might be a good subject for discussion in our correspondence columns. Apropos of the Sun's distance, I was recently examining Delambre's Solar Tables, which appeared in 1806, and was astonished to find that they used the very same value of the Sun's parallax (8″·80) that is now used in the *Nautical Almanack*. Encke's famous value, 8″·5776, announced some years later, was thus a change for the worse.

THE MEROPE NEBULA IN THE PLEIADES.—Lowell Observatory Bulletin No. 55 contains an account of the photography of the spectrum of the nebula; an exposure of twenty-one hours was given with the twenty-four inch refractor, with the surprising result that the spectrum is continuous, with five distinct hydrogen lines and three fainter helium ones, the spectrum being quite like that of Merope itself. This was a great surprise, as the nebula resembles that of Orion, and little doubt was felt that its spectrum would be gaseous. Tests were made to see if diffused light from Merope could have caused the continuous spectrum; the results appear to negative this idea. It is concluded that the nebula shines by reflected light from Merope. It is calculated that Merope would appear nearly as bright as our Full Moon from the region of nebula photographed, and as we can photograph a landscape by moonlight, the assumption of reflected light seems reasonable. Mr. Slipher, the author of the Bulletin, also suggests that the Andromeda nebula (for which a similar spectrum has been found) may also shine by reflected light, but this would only be possible if there were a very bright central star, which is veiled from us by a dense screen of dust or other opaque material. This seems a somewhat strained hypothesis. We have, however, evidence of the existence of such opaque screens in the numerous dark lanes that are shown in photographs of the Milky Way. It would, however, require an artificial and improbable arrangement that the opaque veil should hide the central star from us, while leaving it free to illuminate the nebula.

DISCOVERY OF A COMET IN SOUTH AUSTRALIA.—Mr. Dodwell, the Director of the Adelaide Observatory, has communicated the discovery of a faint comet by Mr. Lowe, at Laura, South Australia, at the end of December. Owing to some delay in the announcement, and the vagueness of the description, the comet was not seen elsewhere, and only a very rough determination of the orbit is possible. I take the opportunity of pointing out that should any readers of this column pick up a comet, they can make observations of sufficient accuracy to be of real value by carefully drawing the small stars visible in the field of the telescope, and fixing the position of the comet as accurately as possible by alignment among the stars, also noting the time when the position of the comet was noted. A rough clue to the position must also be given, which may be obtained by looking along the outside of the telescope tube, and inserting the position on a star map. Tracings of the sketches should be sent to some Observatory, when the region can be identified with the aid of a good star map or a photograph, and a very fair position of the comet deduced. Had Mr. Lowe done this, we should have known the orbit of his comet, and it would have been possible to recover it at other observatories. I have myself tested the possibilities of the method, and find that with care it is not difficult to fix the place of a comet within 30″ or 40″.

OBITUARY.—The Council of the British Astronomical Association has had another loss by death, that of Dr. David Smart. He was an indefatigable cometary computer, and gave invaluable assistance in the laborious work of carrying back the motion of Halley's Comet for two thousand years, and in discussing the extensive series of observations of its recent return that were sent in from all parts of the world.

* Since there are 63,360 inches in a mile we have the curious relation exactly satisfied that on a scale of 1 inch for the distance Earth-Sun a Light-Year is 1 mile.

XUM

BOTANY.

By PROFESSOR F. CAVERS, D.Sc., F.L.S.

VEGETATION OF JAPAN.—Mr. H. Takeda gives, in the February number of *The New Phytologist*, an extremely interesting and readable account of the geography, climate, and vegetation of Japan, which has well been termed the "Britain of the East"—in fact, the author begins with the almost inevitable comparison between the geographical positions of Japan on the Asiatic coast and of Britain on that of Europe. Apart from the geographical resemblance and the existence of a warm current comparable with the Gulf Stream, however, the climate and the vegetation show striking differences, as might, indeed, be expected.

The Japanese Empire consists, from north to south, of the Kurile islands, the southern half of the Saghalien, Yezo, the main island known to the Japanese as Honto, though by others often called Nippon, Shikoku, Kyushu, the Loochoos, Formosa, and the Pescadores; these islands stretch diagonally from 52° to 21° N. Lat., and lie between 120° and 156° E. Long. This area was in 1910 increased by the annexation of Corea, hence the Empire has now about the same area (over two hundred and fifty-six thousand square miles) as Austria-Hungary, and the population (over sixty-three millions) is nearly equal to that of Germany.

A warm current, the "Kuroshio," similar to the Gulf Stream, arises between Luzon and Formosa, and flows along the southern Loochoos to the southern end of Kyushu where it divides into two; the main stream bends northward and flows along the south-east coast of Kyushu, Shikoku, and Honto, while the smaller branch washes the west of Kyushu and the Goto group and runs up to the Sea of Japan through the strait of Tsushima or Krusenstern. The cold currents in the North Pacific which affect the climate of Japan arise in the Sea of Okhotsk and in the Behring Sea; the most important of these, the Kurile Stream, flows southwards along Kamtschatka, turns towards the Kuriles and washes the whole length of the island chain, and then runs chiefly along the east coast of Yezo to 39° N. Lat., where the above-mentioned main stream of the warm current bends away into the Pacific Ocean; the water of this Kurile Stream is very cold, and even in summer its temperature does not rise above 5° C.

These warm and cold currents exert great influence on the distribution of seaweeds; this is clearly seen on the east coast of Japan, the thirty-ninth degree being the separating point of two different alga floras. On the west coast, however, the course of the currents is more complicated, hence the elements of different floras appear somewhat intermixed. The strand flora is similarly affected, the northern elements being distributed in the localities touched by the cold currents. For instance, *Mertensia maritima* (with stouter stem and larger flowers than the type in Europe and America) has a wide distribution from the Behring Sea to 38° N. Lat. in Okhotsk, Manchuria, North Corea, and Honto; *Glaux maritima*, another arctic plant, is distributed mainly from Yezo northward, but also occurs in a locality on the west coast of Honto, whither it was probably carried by the cold currents; *Plantago camtschatica* is another plant found in localities visited by these currents. As the warm current comes into direct contact with the southern parts of Kyushu, Shikoku, and Kii, various sub-tropical plants are found in these places—*Rhizophora mucronata*, *Senecio scandens*, *Ipomaea pescaprae*, *Pteris Wallichiana*, *Asplenium Nidus*, and so on; *Statice japonica*, mainly distributed in south-west Japan, also occurs on the east coast as far north as 38° N. Lat.

The islands of Japan are all mountainous, some of the smaller islands consisting simply of one or more volcanoes, and most of the high mountains are densely clad with luxuriant vegetation from foot to summit, often so densely that the mountain forests are almost impenetrable. The great chains in Central Japan, forming the backbone of Honto, rise in places to three thousand five hundred metres; there are no glaciers, though traces of earlier glaciation have been noted, but considerable névé is present on some of the mountains. As the mountainous nature of the country would suggest, Japan is naturally very rich in water; a dense network of rivers, torrents, and lakes is seen almost everywhere. The rivers are usually short and their gradient steep, causing frequent floods; in late spring, when the snow begins to melt, or when in summer the continuous rain carried by the south-west monsoon falls in torrents, the mountain streams are converted into raging floods.

Owing to the extension over thirty degrees of latitude and the great variety in physiography, the climate is very varied; it is much influenced by that of the neighbouring countries and modified by the warm and cold currents above mentioned. The climate of the region from Formosa northward to the mouth of the Amur River is controlled by the monsoons, formed by the warm damp south wind in summer and the cold north winds in winter; the Loochoos, down to Formosa, are sub-tropical and have practically no winter; while the Kuriles, south Saghalien, and parts of Yezo have the climate of Nova Scotia or Iceland. In the winter drifting ice is carried by currents and wind in the Kuriles and blocks up harbours from November to April; on the northernmost islands, not until June does the snow disappear and vegetation awaken. The rainfall is high (about one hundred and fifty centimetres a year in Tokyo), especially in summer, when the air is very damp, except in Yezo and the Kuriles which are not affected by the monsoon; the winter is dry and fine; the annual temperature range is considerable—in Tokyo the mean temperature is 13°·8 C., maximum 36°·6, minimum 9°·2.

The vegetation is, naturally, well developed, varied and abundant, with about four thousand five hundred cryptogamic and six thousand phanerogamic species—apart from the floras of South Saghalien (three hundred species of vascular plants described) and Corea (two thousand two hundred species, of which about two hundred are endemic). Though Japan is surrounded by seas, in the west it is closely connected with Manchuria through Corea, in the north it reaches Kamtschatka by the Kurile islands, and Alaska through the Aleutian islands, and it also has a connection with Amurland through Saghalien; on the other hand, the Loochoos and Formosa join it to South China, the Philippines and the East Indian islands. Hence, except on the eastern side, it is closely connected with other countries, the floras of which show many signs of close relationship with that of Japan, which was probably connected with the mainland of Asia until a comparatively recent period. Plants indigenous in Eastern Asia are also found in Japan, and teeth and bones of the mammoth have been found in various parts of the country.

The main characters of the Japanese flora are (1) the abundance of species and varieties, (2) the presence of numerous endemic species, (3) the remarkably high proportion of woody plants, (4) the presence of tropical and sub-tropical plants throughout the country. Even in Yezo, the large island of North Japan, are found many representatives of southern floras (*Picrasma*, *Vitex*, *Rhus*, *Hydrangea*, *Aralia*, *Magnolia*, and so on) growing together with representatives of the cold flora; in the northern parts of Honto *Aesculus*, *Zanthoxylon*, *Ardisia*, *Elaeagnus*, *Smilax*, and *Camellia* are often seen. The same or closely allied species have been found in the Tertiary strata of the north of Eastern Asia. Probably in the middle of the Tertiary period, even Saghalien had a much warmer climate, for at that time *Ginkgo*, *Biota*, and *Sequoia* grew there. When, towards the close of the Tertiary, the greater part of the northern Hemisphere was covered with ice, the main island of Japan seems to have suffered very little. Probably since the end of the glacial period and the change of climate in the middle diluvial age, Japan has maintained a fairly warm temperature enabling many plants of warmer climates to survive, while in Saghalien the temperature has been very low so that this island is unfavourable to plants of the warm temperate region. The arctic plants once compelled by the cold climate of the glacial period to come southward were consequently left behind when the climate became warmer, but only persist on the summits of the high mountains.

Starting with the flora established in the Tertiary period, the migration of arctic plants towards the south and of tropical

plants towards the north has caused the present flora to be very complex. The connection of the country with the northern, north-eastern, south-eastern, and southern parts of the Asiatic continent made paths for arctic and tropical plants into Japan; the interruptions between the various islands are bridged over to some extent by currents and wind. Evergreen trees and shrubs and many other tropical plants found their way northwards and became acclimatised to the colder winter night and contented with comparatively high temperature during the day, and above all the warm and moist atmosphere during the summer; while those coming from the north or north-west, where they were accustomed to a severe winter, migrated up the mountains until they obtained the necessary climatic conditions. Investigations of the Tertiary fossil plants of Japan, Amurland, and North America, show that the present flora originated in the large common flora of the northern region of the Far East. One striking feature is that the flora of the north-east part of Japan bears a striking relationship to that of the Atlantic coast of North America. This was noticed by Asa Gray, who compared the two floras and showed that more than sixty per cent. of Japanese plants grew on the eastern coast of North America, or were represented by closely-related species, while only thirty-seven per cent. grow on the western coast. His suggestion that the close affinity between these floras originated in the Tertiary period has been borne out by further geological evidence, and Engler and other phytogeographers have concluded that the two regions were actually connected, and had a similar climate and flora. After the glacial period many plants which migrated towards the south returned northwards and formed the foundation of the present flora of Japan, while in North America a change in climate had taken place between that of east and west—in the west the climate became dry and mild, and caused great alteration in the flora, in the east little change has taken place and many old species have been preserved.

Apart from the northern islands, however, the vegetation of Japan shows little actual resemblance to that of North America. Although the same or closely allied plants occur in both regions, they are not found in the same proportion. For instance, in Japan, *Tsuga* forms continuous and almost unbroken forests of great extent on the mountain slopes, above one thousand six hundred metres from sea level, while in North America this tree is rarely found except scattered in small groves, or as individuals in the deciduous forests; on the other hand, *Picea* and *Abies*, which, in America, form immense forests almost to the exclusion of other species, in Central Japan grow singly or in small groves on the lower border of *Tsuga* forests, or mingled with broad-leaved trees. In northern Japan and on the high mountains of Honto, birches are more abundant than they are in the northern forests of America, and the river banks in the north, like those of North Europe and Siberia, are lined with arborescent willows and alders, which are rare in eastern North America, where these genera are usually represented by trees. Moreover, the numbers given in Gray's estimate should be reduced slightly, since he included as natives some Chinese and Corean plants cultivated in Japan. Besides these and some endemic species, the flora of Japan includes many plants of the boreal region of the old world. For instance, *Asperula odorata*, which occurs in Europe but not in America, is abundant in North Japan. In South Japan, many tropical and sub-tropical elements may be seen; certain plants growing in the central and southern parts of the country have also a close affinity to those of South China, as well as to those of the Himalayas.

The vegetation of Japan may conveniently be arranged in three divisions mainly based on the climatic conditions—(1) Northern Region, extending from 38° N. Lat. northwards to the Kuriles and Saghalien; with the northern part of Corea; (2) Middle Region, including the greater part of Honto and Shikoku, part of the north of Kyushu, and South Corea; (3) Southern Region, including the southern parts of Kii and Shikoku, the greater part of Kyushu, the Bonin islands, the Loochoos, Formosa, and the Pescadores. Within each of these regions the northern and southern portions show certain differences in the vegetation. The northern part of the Northern Region is represented by the arctic, and the southern part by the sub-arctic, with a few elements of the cold temperate flora; in the northern part of the Middle Region the plants of the cold temperate flora are found, in its southern part those of the warm temperate; the Southern Region has warm temperate and sub-tropical plants in its northern part, and tropical plants in the southern.

(1) Northern Region.—The sea coasts are lined partly with sand-dunes and partly with cliffs; salt marshes are but poorly developed. Lists are given for these formations; the exposed parts of the cliffs show many interesting arctic species of *Androsace*, *Artemisia*, *Draba*, *Empetrum*, *Erigeron*, *Salix*, *Saxifraga*, *Sedum*, and so on. Lists are also given for the dry hillsides, humid places in the mountain valleys, the *Sphagnum* bogs (not much in evidence in the other regions, but here fairly well developed), the ponds and lakes, and the forests. The characteristic forest trees are deciduous oaks, birches, cherries, elm, hornbeam, maples, poplars, *Cercidiphyllum* (a peculiar tree, the sole representative of the family Cercidiphyllaceae, and closely resembling Ginkgo in general appearance), and various willows in damp places; conifers are represented by a few species of *Abies*, *Juniperus*, *Larix*, *Picea*, *Taxus* and *Thujopsis*, pines being rare—the only wild species is the small *P. pumila*, usually on mountain summits. Even in Saghalien and the Kuriles there are various woody climbers (species of *Celastrus*, *Hydrangea*, *Rhus*, *Vitis*, and so on), growing in tropical luxuriance—the abundance of these plants in Japan has been attributed to the undergrowth of bamboos which cuts off the light and makes the plants climb up the trunks of other trees. On the high peaks, not much over two thousand three hundred metres, there are interesting arctic plants like *Bryanthus* and *Phyllodoce*, generally on exposed rocks.

(2) Middle Region.—This region is very extensive and mountainous, hence the vegetation is varied. The coasts are lined by pines (*Pinus thunbergii* and so on) and many dune plants: rocky cliffs are infrequent, and show a poorer vegetation than in the Northern Region. The forest trees show great variety; evergreens occur largely, and broad-leaved species are especially numerous; there are many conspicuous spring-flowering species of *Azalea*, *Prunus*, *Pyrus*, and so on. More species of Pinus appear in this region, and *Cryptomeria* flourishes here, while the tall bamboos (mostly species of *Phyllostachys*) form a special feature of the vegetation, being mostly under cultivation and forming dense groves. This region contains the great mountain ranges with perpetual snow in the gulleys, and their flora shows ascending zones of vegetation—illustrated by reference to Fujiyama, the highest volcano in Japan. The gently sloping basal zone, up to three thousand feet, consists of lava and cinders, and is largely covered with grasses, brambles, roses, and bracken, with numerous herbaceous phanerogams, and in places various trees; this passes into the tree zone, divided into a lower belt with deciduous trees (maples, alders, birches, hornbeam, oak, and so on) and many shade-loving plants in the undergrowth, and a higher conifer belt in which *Abies firma* appears first, and is followed by *Larix*, *Picea*, *Tsuga*, and so on. Above two thousand metres, the gradient becomes steeper, and trees are less abundant, the approach to the shrub zone being marked by rowan, rhododendron, alders, stunted birches, shrubby *Spiraea*, dwarf willows, and various Ericaceous shrubs, with herbaceous species of mostly alpine character. The zone from seven thousand five hundred to ten thousand feet belongs to the alpine region, with typically alpine and arctic plants; above this to the summit (about thirteen thousand five hundred feet) is the lichen zone with *Cetraria islandica*, *Cladonia rangiferina*, *Rhizocarpon geographicum*, and so on. The alpine zone of Fujiyama does not contain many plants, though a few are known only from this mountain, but on the other mountains of Central Japan, which form the backbone of the main island, and are often called the Japanese Alps, alpine vegetation is well developed. On these mountains a creeping pine (*P. pumila*), also found in Siberia, appears in the shrub zone and extends to the alpine zone; many interesting plants are found in the shade of the thickets of this pine. Many arctic plants found

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on the rocky cliffs of the Kuriles occur also in the alpine zone of these mountains.

The aquatic vegetation of the Middle Region shows great diversity; the genera, and many of the species are cosmopolitan; *Isoëtes japonica*, one of the largest species of this genus, frequently grows in running water instead of still lakes.

(3) Southern Region.—Even at the northern limit of this region, in Kyushu, the vegetation is quite sub-tropical. On the coasts, washed by the warm current, various Indo-Malayan strand plants are found; in the Loochoos, *Bruguiera gymnorrhiza* forms the mangrove forest in the tidal estuaries; well-developed mangroves are seen in Formosa, consisting of *Avicennia officinalis*, *Kandelia*, *Rhizophora*, and so on. Various palms belonging to the genera *Arenga*, *Livingstonia*, *Trachycarpus*, and so on, flourish in this region, which may be characterised as a region of *Ficus*, with which broad-leaved evergreen trees and shrubs, such as various Lauraceae, *Quercus*, *Hibiscus*, *Myrica*, and so on, are found. On their branches are many epiphytic lycopods and ferns, and sometimes parasites (*Loranthus* and *Viscum*) are found, while in the dense, moist forests there flourish many tropical ferns.

In Formosa also the vegetation is typically tropical, with abundance of huge trees, thick bushes, dense forests with numerous woody climbers, and so on. In the mountain valleys the camphor tree (*Cinnamomum camphora*) reaches great dimensions; *Macuna gigantea* and *Pusaetha scandens* (leguminous trees with enormous pods), other climbers, and gigantic bamboos, tall tree-ferns, palms and *Musa* grow in the forests and on mountain slopes; while higher up on the mountains which occupy the greater part of the island, conifers are seen at an elevation of two thousand metres. *Chamaecyparis formosensis*. *Cunninghamia*, *Konishii*, *Picea morrisonicola*, and *Pinus formosana* are some of the interesting trees, and are only known from this island, while a few years ago a new conifer discovered here was placed in a new genus (*Taiwania cryptomerioides*); and higher up we get first the shrub zone, and then, at four thousand metres and upwards, various alpine and arctic species of *Arabis*, *Artemisia*, *Cerastium*, *Deschampsia*, *Festuca*, *Fragaria*, *Gentiana*, *Luzula*, *Potentilla*, *Sibbaldia*, and so on. The flora of Formosa has some two thousand five hundred species of vascular plants, seventeen per cent. of which are endemic, and doubtless many more remain to be discovered.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

UTILISATION OF MILK WEED.—The current issue of the *Journal of the Society of Chemical Industry* (1913, XXXII, 72) contains a paper by Dr. A. C. Neish, describing experiments that have been made to discover uses for the enormous quantities of this wild plant which are annually wasted. The common milk weed (*Asclepias syriaca*) grows abundantly on sandy or clay soil in the United States and Canada. It produces a milky juice or latex, which yields from two to three per cent. of rubber, but the amount is so small and its quality so poor that its extraction would not be commercially profitable.

On the other hand the bast fibres of the plant are likely to prove a more profitable product, for they can be readily separated, and when bleached yield a white silky textile material, which is stronger than flax, which in other respects it closely resembles. The seeds also contain about twenty-one per cent. of a drying oil which may be easily extracted with a suitable solvent, while the down attached to the seeds is white, very soft and springy and contains 0·9 per cent. of ash. It could be utilised as an upholstering material, as has already been done with the seed hairs of other species of *Asclepias*. The woody tissue, about eighty per cent. of the plant material, yielded, on treatment with soda solution under pressure, a pulp from which paper of good quality could be made. From the results of his experiments in general Dr. Neish considers that it may prove practicable to start a new industry to utilise the product of the common milk weed and similar plants of the same species, but some system of cultivation would probably be required to supplement the supply of the wild plants already available. Such a crop might be grown upon dry or wet soils with which little else could be done.

USE OF ALCOHOL AS A MOTOR FUEL.—The "*Times Engineering Supplement*" for January 15th, 1913, deals with the question of the substitution of alcohol for petrol as a motor fuel. A comparison of the relative calorific values of the two liquids showed that petrol of specific gravity 0·684 produced eleven thousand six hundred and twenty-four calories per kilometre, while methylated spirit gave only six thousand two hundred calories. In practice, however, this superiority of petrol disappears. For example, in comparative tests with the two fuels in specially constructed eight horse power engines, it was found that 340 grammes of petrol were consumed per horse power hour as against 373·5 grammes of methylated spirit, showing that the relative efficiences were as 16·5 per cent. for the petrol and 28 per cent. for the alcohol. The better results given by the alcohol are to be attributed to the greater ease with which it is possible to obtain complete combustion, and to the smaller proportion of air required. In addition to these factors, it is possible with the use of alcohol to obtain greater compression and a cooler cycle, both of which conditions tend to economize fuel.

Although denatured alcohol can be obtained free of duty, its price is still as high as that of petrol at the present time, and the reason for this is not the manufacturing cost, but the charges made by the Government for supervision to ensure that the spirit is not drinkable when it leaves the distillery. A spirit containing about ten per cent. of crude benzene would be undrinkable, and could be manufactured at a cost of about sixpence per gallon, while only slight modifications of the carburettor would be required to enable it to be used in ordinary petrol motors. Hitherto efforts have been directed to the perfection of the petrol engine, and it is possible that when an equal amount of research has been given to discover the best methods of using alcohol, the latter will be recognised as the more suitable fuel.

UTILISATION OF HORSE-CHESTNUTS.—Although several attempts have been made during the last two centuries to utilise the horse-chestnut in the preparation of detergent preparations, none of them have been adopted as commercial processes. As far back as the year 1757 it was discovered by a Frenchman named Marcandier that the juices of this nut had strong frothing and cleansing properties, and that they could be used instead of soap for removing dirt and grease from textile materials. A similar use of horse-chestnuts was known in Germany, as is shown by the account given in 1824 in a technical paper.

After the lapse of years, the idea of using horse-chestnuts for washing preparations has again come to the fore, and since the year 1888 there have been several processes patented for extracting the saponine or frothing substance from the nut. An outline of the methods suggested, and a discussion on profitably utilising the other constituents of the horse-chestnut, is given by M. Rousset in the current issue of *Les Matières Grasses*, 1913, VI, p. 2980.

The kernel, after removal of the shell (which is rich in tannin, and is utilised in the preparation of a tanning extract for leather), contains the following proportion of extractive substances:—Oil, 6·6: aesculic acid, 3·2; carbohydrates, 10·8; reducing sugars, 5·2; gums, 1·2; and proteins, 1·0 per cent.

The oil, which can be extracted with petroleum spirit, is a pale yellow liquid with characteristics similar to those of almond oil. After removal of the oil, the residue, when extracted with dilute alcohol, yields an extract containing about fifteen per cent. of aesculic acid, a substance of a saponine character which has strong lathering and cleansing properties.

Finally, the mass left from the two extractions could be used in the preparation of a white starch, which, after treatment with cold water to remove a bitter principle, would be quite suitable for use as a food.

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

LONDON WELLS.—The water-supply of London is of such tremendous importance that contributions to its fuller study are extremely desirable. Hence the Geological Survey has accomplished a valuable piece of work in compiling an exhaustive record of London wells. The information as to this mode of water-supply is scattered, and in the older records incomplete. So far as is possible this incompleteness has been remedied, and a very large number of borings made during the last few years have been included in the Memoir, which has been compiled by G. Barrow and L. J. Wills. The introduction by Mr. Barrow is a valuable account of London water-supply, and describes the strata penetrated by the wells, methods of well-sinking, relation of water-supply to geological structure, and many other kindred subjects of interest. Part II consists of a catalogue of published London wells, and Part III of a descriptive list of new London wells with some old ones.

Special attention is drawn in the introduction to the continued fall in the water-level under London. The fall is greater than was anticipated, and has recently been taking place at an increased rate. The fall is illustrated by contour-maps of the water-level at different dates in the London area. These show very clearly the setting up of specially low water-levels, and the gradual outward spread of the low contours from these areas. The fall may be illustrated by the three wells sunk in 1847 to supply the fountains at Trafalgar Square. These once produced five hundred and eighty thousand gallons a day, and supplied several government offices beside the fountains. Only one is now in use, and supplies only eight thousand gallons an hour, and in this well the water-level has fallen one hundred and fifteen feet in sixty-four years. A similar instance is offered by the deep well sunk in 1864 to supply the fountains at the head of the Serpentine in Kensington Gardens. There is a general coincidence of the areas of low water-level with those areas where there is a considerable thickness of Tertiary beds, or where the top of the Chalk is a considerable depth below the surface. A great thickness of cover tends to check the rate of inflow of the water from the chalk outcrops, and this, added to the lowering of the water-level by pumping, has produced especially heavy falls in certain areas. Moreover, the Chalk, so often thought extremely permeable, is only so under pressure; and if the head of water in the formations above the Chalk be reduced, as, for example, by the fall in the water level, the passage of water through the Chalk becomes increasingly difficult. The low water-level extends much farther to the north of the Thames than the south. This appears to be due to three main causes. There is a much thicker and more extensive cover of impermeable strata (London Clay) in the north than in the south. This not only prevents rain-water from entering the Chalk, but also tends, by reason of its weight, to hinder the flow of water from the north towards the central areas. Then, again, the intake areas of Chalk are more distant on the north than on the south. Furthermore, the existence of the deep valleys of the Lea and Colne transverse to the general direction of underground water flow towards London, still further depletes the supply on the north as compared with the south. In the latter, not only are the intake areas nearer, but they are not traversed by valleys in which part of the flow towards London might be abstracted by springs.

IGNEOUS QUARTZ.—The theory of the probable direct igneous origin of some quartz veins and masses receives support from observations made by Dr. J. Ball in South-Eastern Egypt. According to the memoir, "Geography and Geology of South-Eastern Egypt" (1912), this area, covering twenty-two thousand square miles, consists principally of ancient metamorphic and igneous rocks, with a few patches of Nubian sandstone (Cretaceous), and gypseous limestone (Miocene?). The igneous rocks include great masses of granite and serpentine, with subordinate syenite, diorite, and gabbro. In addition several masses of quartz-rock of igneous origin have been found. The most conspicuous of these occurs as a group of three hills known as Marwot Elemikan (Marwa = Arabic for quartz). They consist almost entirely of white quartz, and from their dazzling white colour form landmarks visible at a great distance. The only other mineral present is white mica, of which a few spangles occur in the outer portion of the mass. These three bosses, together with another on the south side of the Wadi Khoda, penetrate granite.

Of quartz veins and dykes the best-known example in south-eastern Egypt is a great dyke forming the backbone of a ridge known as Erf el Fahid. This dyke is intrusive in schists, is at least ten metres wide, and can be traced for two kilometres. A similar dyke occurs in the ridges to the south-west of Erf el Fahid.

Dr. Ball considers that the shape of these masses of quartz, their close association with aplites and pegmatites in at least one locality, the absence of ores and of minerals due to deposition from solution and the occasional presence of mica, all point to igneous origin. He considers them as the final ultra-acid products of the differentiation of a granitic magma.

MICROSCOPY.

By F.R.M.S.

QUEKETT MICROSCOPICAL CLUB.—March 25th, Mr. G. T. Harris presented a type collection, numbering seventy-two preparations, of British Hydrozoa.

Messrs. Heron-Allen and Earland read a paper "On some Foraminifera from the southern area of the North Sea, dredged by the Fisheries cruiser 'Huxley'." The work was undertaken with the view of determining the distribution of *Saccammina sphaerica* Sars. and *Psammosphaera fusca* Schulze, in the area mentioned. Material was examined from three stations far to the north-east of the Dogger Bank near the Great Fisher Bank, and from three stations in the belt of deep water lying to the west of the Dogger, close in to the Northumberland coast. The first-named species was found to occur only at two of the inshore stations, but the second species was found in all the dredgings except that from one of the inshore stations. The authors' first intention was to examine the material solely with regard to the presence or absence of these two species, but so many other species were noticed that an exhaustive list was prepared containing one hundred and thirty-seven species, many of which are first records for this area, and were given in detail in a table appended to the paper. A number of excellent lantern slides from photomicrographs of some of the more interesting forms was shown.

Mr. D. Bryce read a paper on "Five new species of Bdelloid Rotifers." Four belonged to the genus *Habrotrocha* and the fifth to *Callidina*. They are fully described and figured in the current (April) issue of the Club's *Journal*.

THE MECHANICAL CONSTRUCTION OF THE MICROSCOPE.—Although the optical parts of the microscope have been greatly improved in recent years, the mechanical construction of the instrument has not advanced in proportion.

The books written on the subject, which have come under the writer's notice, have little to say on general construction, but confine themselves to descriptions of the models by various makers.

The principal faults, in the writer's opinion, are that most microscope stands are built on too small a scale and that there is an unnecessary amount of patchwork in the assembling of the various parts. For some purposes a portable instrument is no doubt desirable, but for general work ample room for manipulation, for the use of low power objectives, and various accessories, is a most important feature.

The optical equipment of the microscope need not here be described in detail; it is sufficient to point out that it consists of two divisions, namely, the upper or magnifying portion, consisting of the ocular and objective, and the lower or illuminating portion, consisting of the condenser, and mirror,

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or source of light; between these must be fixed the stage for carrying the object under examination.

The Stand of the microscope consists generally of two parts, the foot or base which supports the instrument, and the limb which is connected to the upper part of the foot through an inclining joint permitting any angle of inclination from the vertical to horizontal.

Much discussion has taken place concerning the relative merits of the two styles of base generally in use, namely, the tripod or so-called English style, and the horseshoe or so-called Continental style; the former, no doubt, gives greater stability to the instrument in various positions, and the latter provides more room for the manipulation of the substage fittings, especially if these are required to be swung out from the optical axis. A little consideration will shew how these advantages can be combined in a suitable design.

The Limb should be one continuous piece to which all other parts can be attached either rigidly or through slides which allow for the requisite vertical movement. The limb should provide ample room between the top slides carrying the body tube and the stage, so that a low power objective (with a working distance of, say, three inches) can be used when a nosepiece, or objective changer, has been added to the tube.

At the present time other appliances are supplied for attachment to the body, such as a slot for quartz wedge, a vertical illuminator, and so on, for which the space provided is generally quite inadequate; some modern objectives also are of much greater length than those formerly constructed.

In my opinion the construction should allow sufficient room for the use of any accessories necessary with a low power objective when a mechanical stage has been added to the stage proper; if these accessories are not used, and an exceptionally short objective with small working distance could not be racked down far enough for focusing, a matching piece could be used on the body tube.

The space between the limb and the optical centre could be made with advantage greater than usual; it should be such as to allow for a large-sized stage, say five inches in diameter, to be completely rotated with a mechanical stage attached, and to allow the limb to be used as a handle for lifting the instrument without any strain or derangement of the various adjustments.

The stage is preferably carried on a stage bracket; this construction allows for a wide choice of the style of stage and also provides for a slight adjustment to insure the stage being exactly at right angles to the optical axis.

Another point which has been much discussed is the construction of the fine adjustment; in the first place, the coarse adjustment should be made and finished so that it works as smoothly as possible without any sign of backlash in the movement or looseness in the slide; if this is done the fine adjustment need only be used for high powers and need only have a small amount of vertical movement (say one-sixteenth inch).

FIGURE 179.
Section through body.

The fine adjustment mechanism should be as compact as possible and should act directly upon the slide carrying the coarse adjustment; there is no doubt that mechanically the method involving leverage, by which a greater movement is provided and less weight comes upon the fine adjustment screw, is preferable and more sensitive than that in which the whole weight of the body is borne directly on this screw, and it is difficult to see why the latter method should have ever been adopted.

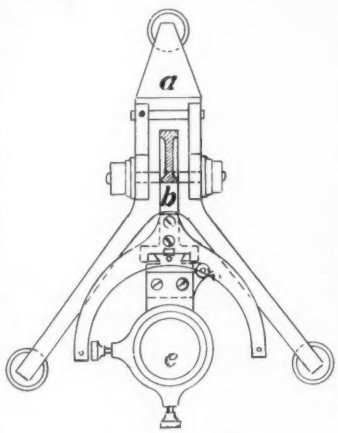


FIGURE 180.
Plan with stage removed.

In most models the under-stage fittings consist of a general patchwork attached indiscriminately to the stage or limb. They should be connected directly to the same limb which carries the stage and the body tube which then forms a continuous support for the optical parts above and below the stage.

Sufficient room should be provided below the stage for a modern condenser, with a stop carrier and iris diaphragm, below which can be placed a large sized polarising prism, sufficient room also for the requisite vertical movement for focusing and dismounting of the various parts conveniently without interfering with the mirror which is also attached to the rim through the tailpiece. It is also advisable that the substage fittings can be swung out from the optical centre.

The line drawings (see Figures 179–181) shew a simple design which complies with the requirements noted above.

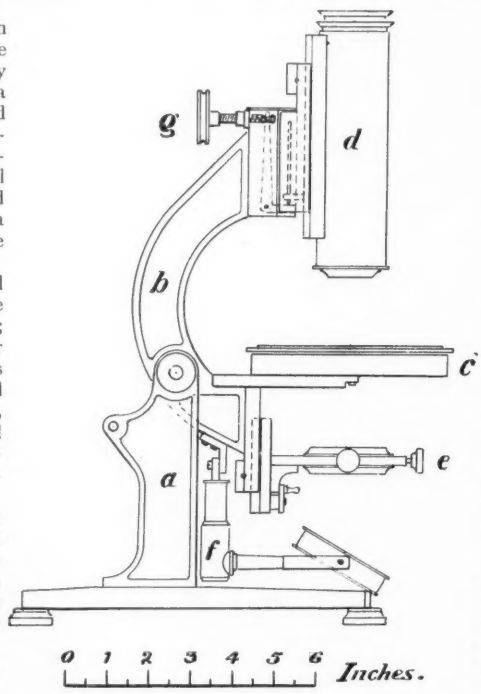


FIGURE 181.
Side elevation. Key to Figures 179, 180 and 181.
A. Stand; B. Limb; C. Stage; D. Body; E. Substage; F. Tail-piece; G. Fine adjustment.

The photograph (see Figure 182) illustrates a more complete model which was entirely designed and constructed by the writer. The chief differences from the design shewn in Figure 181 are that the stand is somewhat higher, the stage has a vertical movement of one inch and that a separate holder is provided for a polariser below the condenser. A short description of this instrument is as follows:—

The stand consists of two parts—the base and the upright. The base is supported on three feet shod with cork, and having a spread of seven inches by eight inches. The upright part has two sides one inch apart, between which the limb is suspended on a pin at the top, and can be inclined at any angle from the vertical to the horizontal, a second pin at the back supporting the limb in the latter position. The upright and horizontal parts of the stand are connected by screws, and can be taken apart when desired to pack the instrument into a small bulk. The limb is cast in one piece, provided at the top with a dovetail slide to carry the body, and at the bottom with a slide to carry the stage bracket and substage fittings. The central portion of the limb is of I section, to secure rigidity without undue weight. The fine adjustment is located at the top end of the limb in a hollow recess; it is actuated by a

divided screw head projecting backwards, which works on the long arm of a "bell crank" lever, on the bottom or horizontal arm of which rests the fine adjustment slide. The reaction is taken up by a vertical spiral spring. The pitch of the screw thread is forty to the inch. The vertical arm of the lever is four times the horizontal. A complete revolution of the fine adjustment screw gives, therefore, a movement to the body of ·00625 inches.

The bearing surface of the fine adjustment slide is two and a half inches in length, and the possible movement about one eighth of an inch.

The body is carried on a slide having a bearing surface of three and a half inches in length, actuated by the coarse adjustment pinion, with a movement of three inches. The main tube is one and five-eighths inches in diameter, and contains two draw tubes giving a latitude of extension of from one hundred and sixty to two hundred and sixty millimetres.

In the body tube, as close to the back of the objective as possible, are—first: an iris diaphragm; second: a slot which can be uncovered or closed by a circular ring, and third: a slide carrying an analyser prism, which can be moved in and out of the optic axis as desired. The two latter accessories, in conjunction with a polarising prism below the stage, are indispensable for petrological work. The advantage of placing the analyser near the objective instead of over the eyepiece—as is sometimes done—is that a much larger field of view is obtained with a small prism. The bottom of the inner draw tube is screwed to receive a "Bertrand Lens." Very perfect interference figures in crystals have been obtained with this instrument.

At the bottom of the body is an objective changer, which is preferred to the usual nosepiece; this is considered as a fixture and is taken into account when measuring the tube length.

A circular stage—five inches in diameter—rests upon a stage bracket. It is provided with centreing screws and divided in degrees reading from a fixed index. Upon the circular stage are two slides in which a mechanical portion is held, having a rectangular movement of two and a quarter inches from left to right and one and a quarter inches at right angles. The stage can be completely revolved with the mechanical portion in any position. The stage bracket is connected to the bottom of the limb through a slide actuated by rack and pinion, by which the stage can be moved in a vertical direction with regard to the limb a distance of one inch. The bearing surface of this slide is two and a half inches in length and can be fixed by a binding screw in any position. This movement of the stage adapts the instrument to metallurgical work, and also allows for a variation of the gap between the stage and body.

The substage fitting is carried on a slide, actuated by rack and pinion, having a vertical movement of two inches with regard to the stage. It is provided with two carriers: the upper provided with centreing screws to hold the condenser; and the lower to hold a polarising prism. These carriers are supported on a vertical pin, upon which they can be separately swung clear of the optic axis without dismounting—they are provided with clamps to hold them in the central position.

The tail-piece to carry the mirror is attached to the limb, and is of the ordinary tubular type, which allows a mirror two and a quarter inches in diameter to be placed in any necessary position or to be swung out of the centre when using the instrument in an horizontal position.

General: All the sliding parts of the instrument were designed to give ample bearing surface for the weight supported, and are all provided with means of adjustment and for taking up any slackness due to wear.

The principal parts were cast in phosphor bronze and the smaller parts, bearing strips, and so on, were made of good quality brass.

The optical parts and some accessories were supplied by Messrs. Watson & Son, as follows:—Objectives and oculars, "Holoscopic" series; substage condenser, "The Universal"; polarising and analysing prisms; objective changer, "Facility."

The total height of the instrument, racked down, without eyepiece, is fifteen inches. The weight, in working order, =17 lbs.

The instrument can be easily disconnected into three parts. The limb with all attachments can be lifted from the stand by the withdrawal of connecting pin in the inclining joint. To prevent accident, the stand at this joint is provided with semi-circular cheek pieces, which support the limb when the pin is withdrawn. The stand can then be taken into two parts—the vertical and horizontal—which are connected by quarter inch screws. When thus disconnected, the instrument can be packed into a case twelve and a quarter inches by nine inches by five and a quarter inches inside measurements.

GEORGE G. HOLMES, A.R.S.M

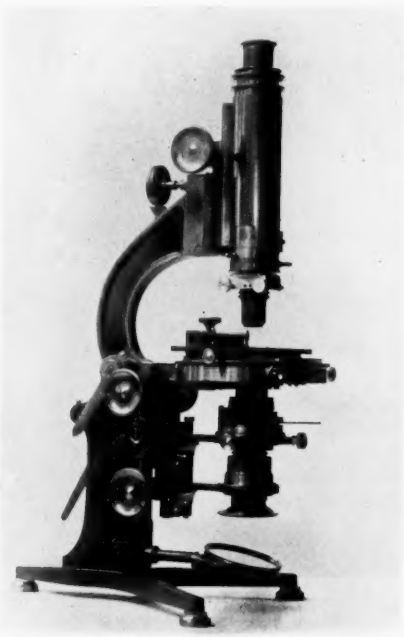


FIGURE 182.

Complete microscope. Designed and constructed by the writer.

PHOTOGRAPHY.

By EDGAR SENIOR.

CRYSTALS AND X-RAYS.—Of the endless number of instances in which photography has come to the aid of the original investigator, none perhaps are of greater interest and value than the one which has recently led to the discovery of the interference effects obtained with X-rays, by means of crystals. Ever since Röntgen rays were first discovered in 1895, attempts have been made to obtain results analogous to interference, diffraction and reflection of ordinary light waves, but always until recently with negative results. The wave lengths of light visible to our eyes are those which are comprised between 7594 (red) and 3930 (violet), and beyond the violet are those of shorter length, known as ultra-violet, to which photographic plates are particularly sensitive. Now, it has always been supposed that X-rays were of the nature of ultra-violet light of extremely short wave length, quite beyond the limits of the spectrum known to us. The experiments, however, carried out by Messrs. Friedrich and Knipping at the instance of Professor Laue, opens up a new range of the spectrum which was unexplored before. In conducting any experiments by means of the spectrum of visible light, a diffraction grating is very commonly used in order to decompose the light into its constituents, from which the wave lengths can be measured. A diffraction grating is usually a plate of glass having a number of fine lines ruled upon it at regular intervals, the lines being practically opaque, acting as so many diffracting objects, while the clear spaces between allow of free transmission of the light. The spectra produced by means of gratings are known as interference spectra. Now, as it was supposed that X-rays consisted of waves of very short length, Professor Laue formed the conclusion that it might be

possible to obtain interference effects with them, by using a crystal as a diffraction grating. As the atoms of a crystal are arranged regularly, and the spaces between them have about the same relation to the supposed wave length of the rays as the "constant" of a diffraction grating has to that of visible light, a crystal would thus form a most perfectly ruled grating for them. In order to test this practically the aid of photography was called in. In the first place, however, it was necessary to obtain as far as possible a parallel beam of X-rays, so that the conditions should be the same as when a parallel beam of light is allowed to fall upon the grating of a spectroscope. This was accomplished "as well as could be," by means of holes pierced in sheets of lead, the X-rays being finally transmitted by an aperture of one millimetre in diameter, and thus a very narrow pencil was obtained. This was allowed to fall upon the crystal, and behind it, at a distance of about three centimetres, a photographic dry plate was placed perpendicular to the beam of rays. The rays, after traversing the crystal, fell upon the plate, and this, after the necessary exposure (which amounted in some instances to several hours), was developed. The effect produced was shown as a dark, circular spot, surrounded by a series of much weaker ones, arranged in regular order. By altering the distance of the photographic plate from the crystal, the spots could be made to approach, or recede from, the central one, so that it appeared clear that they were due to narrow rectilinear pencils spreading outwards from the crystal. It was found that the angles some of these made with the undeviated rays were as much as forty degrees. It was also noticed that the spots scarcely altered in size as the distance between the plate and the crystal was increased, but remained of the size of the smallest aperture employed for the transmission of the rays. And whatever the final result of the experiments may lead to, whether they solve the problem of crystal structure as well as that of the true nature of X-rays, there is no doubt but that photography has again rendered great service in showing that which otherwise might have remained of theoretical interest alone.

FIXED FOCUS CAMERAS.—Fixed focus is the term applied to hand cameras in which the plate is placed at a fixed distance from the lens, so that no focusing of the image can be accomplished. In many cases the plate is at a distance greater than the focal length of the lens; in other cases it is at the focal length itself. Now, in order for an image to appear sharp, it is generally considered that any point in the image of an object must not exceed one hundredth of an inch in diameter. Therefore, the distance of the object must be such that these points, "termed discs of confusion," do not exceed this value in the image. When the plate is at a distance from the lens greater than its focus, then a slight amount of confusion exists for objects at infinity. If, however, the plate is placed at a distance from the lens equal to its focal length, then all objects from a certain near point to infinity are in sharp focus. In order to find this point the following formula is employed:— $\frac{(f)^2 \times 100}{a}$ where f = the the focal length of the lens, and a the value of the stop. Thus, suppose with a lens of five inches focus and stop F/6 it is desired to find the nearest point beyond which everything else would be in focus, then $\frac{5^2 \times 100}{12 \times 6} = 34{\cdot}7$ feet.

Therefore, all objects from this distance to infinity would be sharply focused: that is, the circles or discs of confusion forming the points in the image of the objects would not be greater than one hundredth of an inch in diameter with the stop employed. When the object is nearer than this, then the image will be at a greater distance, and will agree with the case first stated, and although there may be certain advantages attending it, the method given for calculating that of the object would no longer be correct, as the formula only holds good when the plate occupies the position of the principal focal plane of the lens. There are, doubtless, many cases in which strict attention to theoretical details need not be paid, this, of course, depending largely upon individual ideas; but it should always be remembered that when images are intended for enlargement either by means of lantern slides or otherwise, the results are likely to suffer in a serious manner if too little attention be given to obtain a sufficiently sharp image in the first place.

PHYSICS.

By ALFRED C. G. EGERTON, B.Sc.

RÖNTGEN RADIATION.—When the cathode rays—the rays emitted in a vacuum tube normally to the cathode—were originally discovered, some considered them to consist of small discrete particles, and others considered them to be waves in the ether. Professor Sir J. Thomson's researches eventually proved without doubt that the rays consisted of negative charges emitted with great velocity carried by corpuscles of mass, one seventeen-hundredth of the mass of the atom of hydrogen. The cathode rays, when they impinge on a substance, are stopped, provided the thickness of the substance is sufficient, and they give rise to another penetrating type of radiation called the Röntgen rays, after their discoverer. The rays evolved are rays of mixed penetrating power, but for every metal there is also a definite radiation, characteristic of that metal and of definite penetrating power; the higher the atomic weight of the element, the greater the penetrating power of the characteristic radiation. Now, the Röntgen or X-rays give rise to secondary rays on being allowed to impinge on a metal, and these rays, too, are found to be characteristic of the metal, their velocity varying with the atomic weight of the metal. Thus, a cathode ray gives rise to an X-ray, and an X-ray to a secondary ray of the same type as the cathode rays. The γ-radiation from the radio-active substances is also in all its properties similar to a very penetrating Röntgen radiation.

Now, discrete electrically-charged particles, be they positive or negative, are affected and bent out of their path by magnetic or electric fields, but the X-rays or γ-rays are not affected by such fields. Consequently, the rays must be either neutral and consist of a pair of equal and opposite electrical charges, or consist of a pulse (a kind of single wave) in the ether. It cannot be said that complete proof has been adduced in favour of either view. But the latter theory explains most easily the majority of the facts, while the former has for support the ready convertibility of the X-rays and "secondary" β radiation, though with the pulse theory there is no great difficulty in considering that since an electron possesses around it an electro-magnetic field, and when stopped it is the inertia of this field which continues in motion and gives rise to a pulse in the ether. The energy of the pulse may be absorbed by obstructing matter, but addition of energy to an atom in that way is almost similar to adding an electron, and so an electron is released from the atom and forms a secondary ray. Recently, Professor Barkla has been able to demonstrate the reflection of X-rays from the cleavage planes of a crystal of rock salt. The narrow pencil of X-rays was allowed to fall at grazing incidence, and the principal secondary pencil of rays formed was one obeying the laws of reflection from the cleavage planes. It has also been possible to demonstrate the formation of Interference Fringe systems: a diverging beam of radiation was so directed on to a crystal that various portions of the beam were directed at different angles on the crystal cleavage planes; it was found that the intensity of the reflected pencil varied periodically with varying angle of incidence, and that such maxima of intensity that were obtained could be explained by the interference of the various reflected radiations from different equal spaced parallel planes within the crystal. The wavelength works out to be $\cdot 6 \times 10^{-9}$ centimetres which agrees with the probable wave-length of the X-radiations from other considerations.

These experiments have added to many others carried out by Professor Barkla and his collabrators in favour of the Ether pulse theory of the Röntgen rays.

"THE DYNAMICS OF PIANOFORTE TOUCH."—This is the title of a paper by Professor Bryan read before the Physical Society on February 14th; the automatic piano player, unlike the gramophone, has not been given great

prominence in scientific literature. Professor Bryan has now introduced the subject and has, moreover, invented a device which improves the mechanical player in connection with its "touch." The theories of Helmholtz and Kaufmann on the action of the pianoforte are very incomplete and do not take into account either the sounding board or the time and nature of the impact of the striking keys. It is this last factor which controls the quality of the tone given by the vibrating wire, and the quality of the tone is regulated by the "touch" of the pianist; the problem is whether a mechanical player can be devised which will be capable of adjustment so that its touch can be modified. Professor Bryan, by means of a lever which regulates the air pressure, has succeeded in imitating mechanically to some degree the touch of the human hand. Still, the touch and emphasis which can be given by the hand to a single note amongst many others within a number of chords is still a problem which it would seem to be somewhat difficult to solve in a mechanical player.

UNDAMPED OSCILLATIONS.—Electrical waves can be produced either in a continuous train or as a succession of damped vibrations, as with the oscillations produced for the purpose of wireless telegraphy by means of the spark discharge. The production of a continuous train of waves is the type of oscillation which is employed by Poulsen in his systems of wireless telegraphy and telephony. An oscillation circuit of this type can be conveniently set up for laboratory purposes in the following way, and it may be pointed out that it is a very convenient method of obtaining discharges through gases at low pressures, when it is not possible to use metallic electrodes.

An arc is constructed of copper and carbon, the carbon is fitted in a brass tube, which passes air-tight through another brass tube fitted through an indiarubber cork; the carbon can be rotated or moved in and out by rotating the brass tube. The copper is screwed to the end of a brass tube passing through a rubber cork, and down which passes an iron tube through which water passes into the brass tube; the copper electrode can thus be cooled. The corks fit into the ends of a silica tube, which is cooled by an outer tube, through which water passes. The arc is connected through suitable resistance, giving about two or three ampères, to the two hundred volt mains. The arc is also connected to a variable inductance—a coil of insulated wire wound on a wooden frame, and so bared that a slider brings in more or less inductance, and a variable condenser connected in series. If a large inductance and capacity, consisting of a long coil of fine wire wound on a tall glass cylinder, is connected to one end of the first inductance, electrical oscillations are set up and are of sufficient intensity to illuminate vacuum tubes situated several feet away.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A.

UTILITY OF SENSITIVENESS TO LIGHT.—It is well known that many animals are very sensitive to different degrees of illumination—some seeking more light and others less. Dr. V. Franz gives some good illustrations of the utility of this sensitiveness. Many larvae hatched on the floor of the sea make for the light, which is the best thing they can do for nutritive and other reasons. Still more frequent is the case of animals which show marked light-sensitiveness only when some unusual conditions have intervened, such as perturbations in the water or foulness of water. They retreat in the direction of the light conditions they are accustomed to. They make for stronger or weaker light, as the case may be, and the degree of illumination has a directing influence in a sense. But it is not the degree of illumination in itself that is significant; it is the avoidance of concomitant unpropitious conditions.

MANGANESE IN ANIMALS.—It has been usually supposed that traces of manganese detected in various animals were accidental and without physiological significance. But that is not the view taken by Messrs. Bertrand and Medigreceanu, who have found manganese in dog, boar, pig, ox, sheep, horse, rabbit, guinea-pig, seal, dolphin, fowl, duck, angler, herring, and dogfish. It occurs everywhere in these animals except in white of egg. There is great diversity in amount, the maximum occurring in the oviduct of birds. Liver and kidneys contain more than muscle or nerve. There is a relatively large amount in hair, feathers, and nails. The authors maintain that manganese must have some physiological significance, probably as a catalytic agent.

PERCHING IN BIRDS.—From the time of Borelli it has been stated that the tendon of the ambiens muscle in many birds is continued over the knee, and enters into connection with the tendons of the perforati muscles which bend the toes. When the knee is bent, the story runs, the ambiens tendor is stretched, and through the mediation of the others, clinches the toes on the branch. Professor Brauer points out that the ambiens (which starts from the spina pubica) is connected by its tendon with the tendon of the flexor of the second or third toe, or with the third and fourth (which are closely wrapped up together), but that it has nothing to do with the bending of the first toe. In fact, its importance has been greatly exaggerated. It has little effect in bending the toes, and it is absent in many birds which ought theoretically to have it. The bending of the toes is due to the perforati muscles and the tightening of their tendons when the intertarsal ankle joint is bent.

REPRODUCTIVE DISHARMONY IN WILD DUCK.—Julian S. Huxley calls attention to a remarkable "disharmony," to use Metschnikoff's term, in the reproductive habits of the wild duck (*Anas boschas*). The sexual appetite is extended through the period of incubation. When the female is actually on the nest this cannot be gratified; hence, when a female leaves her nest, she is often pursued by a number of unsatisfied males. This may readily end in the drowning of the overtaxed female. At Tring Reservoirs a considerable number (probably seven to ten per cent.) of the females are killed in this way every year. This is a noteworthy loss to the species, due to a disharmony within itself.

EXTRAORDINARY REGENERATIVE CAPACITY.—E. Uhlenhuth removed the eyes and the surrounding skin from the larvae of salamander and newt (*Salamandra maculosa* and *Triton alpestris*), and implanted them in the back of other larvae of the same species. The implanted eye first underwent degeneration, and the visual cells disappeared. But after some weeks there was regeneration, and the retina showed the typical structure. The optic nerve grew, and with the co-operation of the adjacent tissue, it formed a long strand, which in certain conditions may grow into connection with a spinal ganglion.

A KING-CRAB ON THE SURFACE.—R. B. Seymour Sewell reports from the "Investigator" the capture of an adult king-crab (*Limulus moluccanus*) in a large surface tow-net, allowed to drift with the tide from an anchored vessel, and kept on the surface by means of a bamboo float. How an animal, so obviously a dweller on the floor of the sea, had been carried or made its own way to the surface remains a mystery.

HABITS OF TRILOBITES.—Hans V. Staff and Hans Reck have made an interesting and ingenious attempt to work back to the habits of these ancient extinct types. They argue from structural peculiarities to the mode of life. The primitive Trilobites were creeping animals, and some retained this habit. The *Olenellus* type illustrates adaptation to creeping. But some, such as *Phillipsia* and *Illaenus*, became swimmers; and some went further, like the laterally-expanded *Deiphon-Acidaspis* types, becoming adapted to plankton-drifting. Some, like *Dalmanites*, got long terminal spines suited for creeping in the King-crab fashion. Some, which had progressed on the swimming line of evolution, relapsed and became creeping types again. There is a fascination in this attempt to put life into fossils, making them move about again each after its kind.

XUM

SOLAR DISTURBANCES DURING MARCH, 1913.

BY FRANK C. DENNETT.

ONLY one day has been quite missed during the month, namely, March 4th. The spot disturbances have been both few and insignificant in appearance, yet one at least was of importance. The disc appeared to be quite free from disturbance on twelve days (3rd, 7th, 9th, 10th, 15th to 17th, 22nd, 23rd, 26th, 27th, and 31st). The central meridian at noon on March 1st was 309° 17′.

On March 8th, at 1.30 p.m., there was an evanescent group of minute pores in high southern latitude, but clouds prevented the exact determination of their position. Observations earlier in the day failed to reveal them.

No. 5.—A small pore close to a faculic patch seen on the 13th and 14th only. It was specially noticeable owing to its high latitude, 34° South.

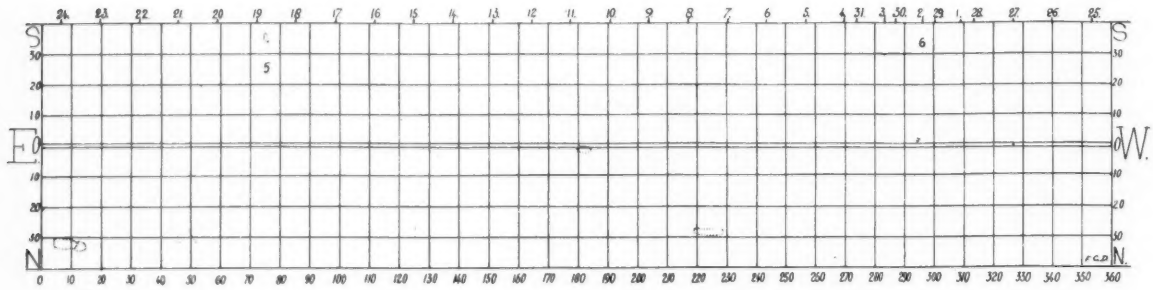
No. 6.—A group of pores only seen on the 28th, very near to the equator.

The photosphere appeared to be in an active state on the 27th, dull spotlets appearing and disappearing in the north-western quadrant.

Faculic patches were visible in the south polar regions on the 5th, 6th and 8th, also on the first two dates close to the equator, near longitude 180°. On the 1st and 2nd the faculic remains of No. 4 were visible near the north-western limb, and from the 18th to the 21st were advancing from the north-eastern limb, re-appearing on the 29th as they approached the north-western limb. On the 29th and 30th another patch around longitude 225° was visible near the north-eastern limb.

Our chart is constructed from the observations of Messrs. John McHarg, E. E. Peacock, W. H. Izzard, A. A. Buss, and the writer.

DAY OF MARCH.



CORRESPONDENCE.

PHYLLOTAXIS AND THE DISCAL FLORETS OF COMPOSITE FLOWERS.

To the Editors of "KNOWLEDGE."

SIRS,—A few months ago I published a paper in "KNOWLEDGE" on the ray and discal florets of *Senecio Jacobaea*. The following note is a supplement to it. The plant, of which a specimen is appended, so that you may have it identified, is fairly common about Cordoba. In appearance, it is something between our blue cornflower and a rampion, with the colouring of the latter. It is well-suited for the purpose, the sterile ray- and fertile discal-florets being neither of them very numerous, but there was not enough of the plants to repeat, on anything the least like the same scale, the elaborate observations on the small wild calendula, nor for that matter was there any reason for attempting it. At the same time the present observations seem to put beyond any reasonable doubt the fact that the coincidence shewn in the number of the florets with numbers indicating a system of concentric rings is far more than chance would give. The reasoning is simple enough, and I do not think there is any serious flaw in it. The number of circular ring systems was found for the digit series from the lowest discal number to the highest discal number + the ray florets, and the percentage of coincidences was found to be nearly three times what chance would give. Taking, however, what may be considered the normal types of flower head with 17, 18 and 19 rays, the percentage was much higher. In fact, for the 18-rayed type it was 90·9 instead of 20%. For the sake of brevity (3), (4), (5), and so on, are put for "a system of concentric rings beginning with 3, 4, 5, and so on." When a number has one dot over it, that means that it belongs to a ring system, either with or without the ray florets being counted in; when two, that it belongs to both.

TABLE 36.

Giving all the ring systems in the tract of numbers to be dealt with, viz., from 28...to 100 or 72.

Ring System.	No. of Concentric Rings.		
	3	4	5
Beginning with a ring of 3 ...	—	48	75
" " " 4 ...	—	52	80
" " " 5 ...	—	56	85
" " " 6 ...	—	60	90
" " " 7 ...	39	64	95
" " " 8 ...	42	68	100

TABLE 37.

Results of first counting:—

Rays.	Flower Heads.	Discal Florets.
11	1	
12	0	
13	1	
14	1	
15	4	
16	5	39, 41, 54, 56, 61
17	7	50, 50, 51, 52, 54, 56, 63
18	7	42, 48, 49, 64, 64, 69, 56
19	12	46, 48, 49, 50, 53, 56, 56, 62, 63, 66, 68, 71
20	5	53, 58, 59, 62, 69
21	5	49, 72, 74, 78
22	0	.. .. ..
	41	

Nine ring systems in 39 corresponds to 23%.

Thirteen coincidences in 41 counts to 31%.

There are, however, 13 coincidences, one off, so that we have about 1½ what chance should give.

If we count in the rays we have numbers from 55...99, in which series there are again 9 ring systems or 20%. Excluding the ring systems under 52 we then have just 15 coincidences, or about 34%.

TABLE 38.

First and subsequent countings together:—

No. of Ray Florets	Flower Heads.	Discal Florets.	
13	3	28, 29, 41	(3)
14	4	35, 35, 44, 46	(4)
15	11	35, 38, 40, 42, 43, 45, 47, 53, 53, 62	(10)
16	10	39, 39, 41, 41, 43, 49, 51, 54, 56, 61	(10)
17	18	35, 39, 40, 43, 46, 46, 48, 50, 50, 51, 51, 52, 54, 56, 63, 65, 65	(18)
18	11	34, 39, 42, 48, 49, 50, 60, 61, 64, 64	(11)
19	19	44, 46, 48, 49, 50, 51, 53, 54, 55, 56 (3), 59, 62, 63 (2), 66, 68, 71	(19)
20	9	44, 49, 53, 58, 59, 62, 65, 69, 70	(9)
21	8	49, 54, 72, 74, 75, 78	(6)
22	1	64	(1)
	94		

Thus the total number of coincidences is 48. The range is 28 to 99 or 71 with 13 ring systems.

$\frac{13}{71} = \frac{x}{100} = 18{\cdot}3\%$ ring systems.

$\frac{48}{91} = \frac{x}{100} = 52{\cdot}8\%$ coincidences with ring systems, or nearly three times what chance would give.

If, however, we take the three commonest forms 17, 18, 19, with the most numerous countings we get 17 range 35...82, *i.e.*, in 47 digits there are 10 ring systems or 21·25...% observation gives 55·5%.

18 range 34...82, 48 digits with 10 ring systems or 20·8% observation gives 90·9%.

19 range 44...90, 46 digits with 11 ring systems or 24·0% observation gives 57·8%.

21, 20·0% observation gives 50%.

W. W. STRICKLAND.

HEN BIRDS ASSUMING THE PLUMAGE OF THE MALE BIRD.

To the Editors of "KNOWLEDGE."

SIRS,—The experiments carried out at Graaff Reinet, Cape Colony, in removing the ovaries of the hen bird in Ostriches and thereby causing the plumage to be that of the male bird, are very interesting.

As is well known, hen pheasants and probably hens of poultry, also assume the garb of a male bird if the ovaries become diseased, or are removed, and it would be interesting to carry the experiment still further, and find whether all hen birds would be affected in the same way. I think it is probable that it would be so.

Some years ago an old male Ostrich in these Gardens assumed the plumage of a hen bird, and was evidently badly diseased before the change occurred, as he shortly after died; unfortunately I was absent at the time, so the skin was not preserved.

The effect of the removal of ovaries in animal life is well known.

DUDLEY LE SOUËF, C.M.Z.S., *Director.*

ZOOLOGICAL GARDENS,
MELBOURNE.

ON THE RELATIONSHIP OF APERTURE TO POWER IN MICROSCOPE OBJECTIVES.

To the Editors of "KNOWLEDGE."

SIRS,—After reading Mr. Hutton's interesting article on the craze for aperture, which appeared in "KNOWLEDGE" for February, I looked up some of the points in Wright's "Principles of Microscopy" and came across the following, which raised the question, "How are we amateurs to decide when doctors disagree." On page 225 the following is given:—

"*Example*: In the case where a 100-fold magnification is to be exacted . . . and where our choice lies between . . . N.A.'s of 0·6 and 0·3 respectively, preference ought, other things being equal, to be given to the former. The 0·6 objective would not only gather in more light into the image and give better resolution in depth, but it would give us the required magnification in association with a terminal beam of 0·006 N.A., *i.e.*, a beam which would fill the whole aperture of the pupil. The 0·3 objective would, in association with a hundredfold magnified image, give us a beam of 0·0003 N.A., *i.e.*, a beam whose diameter would be less by one half than the diameter of the pupil."

The differences between the two writers is curious. Mr. Hutton, taking the average power of resolution of eyesight at one hundred and twenty five lines to the inch, gets an N.A. of 0·13, sufficient with a magnification of one hundred. Sir A. E. Wright, taking the diameter of the pupil, recommends an N.A. of 0·6 for the same magnification. Thus, while both are guided by the limits of human eyesight, the results they arrive at are widely different.

Nor is this the only difference between the two writers, for Mr. Hutton says: "Besides, we sacrifice depth of focus" by going in for a larger aperture, whereas, according to Sir A. E. Wright, quoted above, the higher N.A. gives "better resolution in depth."

C. H. DE MELLO.

RIVERSIDE,
CASTLE STREET,
SALISBURY.

XUM

REVIEWS.

CHEMISTRY.

Modern Inorganic Chemistry.—By J. W. MELLOR, D.Sc. 871 pages. 316 illustrations. 8½-in.×5½-in.

(Longmans, Green & Co. Price 7/6.)

No one who has had any experience in teaching chemistry can fail to have been struck with the difficulty of inducing a beginner to get a grasp of the general principles of the science as distinguished from the numberless facts upon which they are based. This is often lost sight of, however, in text books, largely because a knowledge of detail "pays" best in examinations. It is, therefore, a pleasure to meet with a book in which stress is laid upon the point that it is more important to train the reasoning faculty than the memory. In fact, the views of the author on this point may be summarised in the aphorisms that we find in different parts of his book; as, for example, "The best chemist is not necessarily he who is familiar with the greatest number of compounds;" and "Dictionaries of chemistry, not the memory, are the natural storehouse of isolated facts."

At the same time, it must not be inferred that the facts essential to understanding a theory are omitted. On the contrary, throughout the book the evidence for and against particular views is cited, and the student is, to a large extent, encouraged to draw his own conclusions. The only instance where generalisation seems to have been carried too far is in the account of the elements of the rare earths, to which only two pages are given.

The chapter upon radioactivity is particularly clear and full, and is well illustrated by diagrams. Although the author does not expressly say so, he evidently regards the experiments of Sir William Ramsay upon the transmutation of copper into lithium and sodium as "not proven." Prominence is also given in this connection to the view of Professor Armstrong (1912) that "radioactive elements" may not be really elements at all, but compounds of ordinary elements with helium.

The book is quite sufficiently advanced to deserve references to the original authorities, so that any student may be encouraged to follow up a subject further. This would add greatly to the value of the work.

In an epilogue, Dr. Mellor remarks: "The teacher has failed in his work if he has not whetted the student's appetite for more." If we apply this standard to his own book we can say without hesitation that no one with any taste for chemistry can read it without being interested and stimulated both by the matter itself and the way in which it is presented, with appropriate quotations from great chemists and natural philosophers as introductions to the different sections.

C. A. M.

Questioned Documents.—By ALBERT S. OSBORN. 501 pages. 200 illustrations. 10-in.×7-in.

(London Agents for American Publishers: Sweet & Maxwell. Price 30/- net.)

This book belongs to a class of works against which objections are sometimes brought upon the grounds that they may be of use to criminals and so defeat their own end. But we venture to think that no one who studies Mr. Osborn's most valuable book will endorse this view, for it will be seen that the pitfalls are so numerous that in avoiding one a forger must inevitably fall into another.

Every scientific question which has to be answered in deciding whether a document is genuine or not is here fully discussed, and the author rightly lays stress upon the point that a reason ought to underlie every expression of opinion upon a matter of this kind.

The methods used in the examination of the writing, the paper, the ink, and so on, are described at length, and well illustrated with diagrams and photographs of exhibits in actual cases in which Mr. Osborn has been engaged.

Throughout the book the use of scientific appliances is advocated wherever practicable. Special cameras and microscopes are described and directions are given for the most suitable methods of applying them to the examination of documents; micrometer callipers and micrometer eyepieces are to be used for the measurement of lines and spaces; and the tintometer for recording differences in colour.

In dealing with the judgment of handwriting the author gives an excellent survey of the more modern and scientific methods of solving a very difficult problem, while a separate chapter is devoted to the effect of the position of the pen, and the pressure applied to it, upon the character of the writing.

There is only one important direction in which we can suggest an improvement for a future edition. A short outline of each of the illustrative cases so frequently cited in the text might with advantage be added in the form of an appendix, as is done in Mr. Justice Wills' "Circumstantial Evidence." This would add greatly to the interest of the work without in any way detracting from its scientific value.

But even in its present form the general reader will find much to entertain him in this book, while to the lawyer it should prove invaluable. It has already met with a warm welcome in America, and it only requires to become known to be equally in demand in this country.

C. A. M.

The Problem of the Gas-Works Pitch Industries and Cancer.—By H. C. ROSS, M.R.C.S., L.R.C.P., J. W. CROPPER, M.B., M.Sc., and W. J. A. BUTTERFIELD, M.A., F.I.C. 48 pages. 2 illustrations. 8½-in.×5½-in.

(John Murray. Price 6d. net.)

For some years past the prevalence of warts, ulcers, and epitheliomatous cancer among persons engaged in the distillation of gas-works tar and and the manufacture of briquettes from gas-works pitch has been recognised, but hitherto no explanation has been given of the remarkable fact that the similar pitch from blast-furnace tar does not produce these effects.

In this little book we have the interesting results of a research made by two physiologists and a chemist in an attempt to discover the causes of this phenomenon. Starting from the hypothesis that cancer is the result of certain factors which include (1) rapid proliferation of cells upon a chronically injured site; and (2) an abnormal tendency of these cells to migrate into neighbouring tissue, experiments were made to discover what chemical agents were capable of stimulating these tendencies to rapid growth and abnormal migration.

The method employed was based upon the fact discovered in 1909 by Drs. Ross and Cropper that human white blood cells could be made to reproduce by cellular division, in response to the action of certain chemical substances such as creatinine, methylamine, and other compounds (extracted, *e.g.*, from dead animal matter). Some thirty-one different substances were discovered, capable of causing such cell proliferation, and to these the name of *auxetics* was given. The action of these compounds was also proved physiologically; for, when applied to the surface of ulcers, they produced granulation tissue and accelerated the healing process.

A second class of bodies, working in association with auxetic agents, caused unsymmetrical division of the blood cells and excited amoeboid movements which would give rise to infiltration of the cells into neighbouring tissue. These bodies were termed *kinetics*. Now, in experiments with aqueous extracts of the two kinds of pitch, it was found that that derived from the gas-works contained both auxetics and kinetics, but that the extract from blast-furnace pitch, while containing a small amount of auxetics, showed no signs of kinetics, and did not produce amoeboid movements in the white blood cells.

From this the conclusion was drawn that the pathological effects of gas-works pitch was the result of chemical injury and not of mechanical injury caused by irritation produced by the coal dust, as had previously been supposed. Attempts to remove these chemical substances by washing the pitch were successful on a small scale, but washing would not be practicable in the works, since it would interfere with the binding properties of the pitch.

The results of fractional distillation of the tar showed that it was not possible to eliminate the dangerous products at a lower temperature than 360°C, and that pitch which had been heated to that extent was useless for practical purposes. Washing the tar with hot water before distillation completely eliminated the auxetics and kinetics, and the pitch from such tar would be as valuable as that now used in making briquettes. There would certainly be difficulties in the manipulation of the tar, but these should not be insuperable.

Such, in brief, is an outline of the main results and conclusions of a most striking investigation attacking the cancer problem from the chemical side. Further researches are now being made to isolate the definite chemical compounds from the gas-works tar and pitch, and since the publication of the present work it has been discovered that there is a pronounced difference in the proportion of auxetics and kinetics in different kinds of coal. This is one of the reasons why blast-furnace pitch (largely derived from hard coal) does not produce the effects of gas-works pitch (from bituminous coal). Another factor is the difference of temperature at which the two kinds of tar distil.

The details of this investigation have been communicated to the Home Office, and they appear so convincing as to the causes of the evil, that it ought to be possible to devise precautions that will entirely prevent it.

C. A. M.

GEOGRAPHY.

Papua or British New Guinea.—By J. H. P. MURRAY. With an introduction by SIR WILLIAM MACGREGOR, G.C.M.G., C.B., D.Sc. 388 pages. 38 illustrations. 9-in. × 6-in.

(T. Fisher Unwin. Price 15/- net.)

Of all the British possessions few are less well known than Papua. There is a great deal of pioneer work to be done in all directions. The geology and the natural resources, the geography and ethnology have been only superficially investigated, though at present investigations on all of them are being pursued. Most people seem to associate New Guinea with rain and perpetual mists, and a book which helps to dispel these mists and others that cloud general knowledge of this most interesting land is decidedly welcome, and does not need the apology with which the modest author prefaces it.

Some peculiarities of the people of Papua are very striking. For instance, on Rossel Island, to the south-east, traces of separate languages for men and women are found. The disabilities of women are curious. On Rossel they must not speak in a canoe, and the native, on being asked what would happen to one who transgressed, suggests that she might probably be eaten, but refuses to contemplate such an unheard-of occurrence. Even the men of Rossel speak a different language when they are on the neighbouring island of Roa, for some mysterious reason. On the Gulf of Papua, again, we find a South Sea snobbery. The possession of tails is imputed to the despised tribes. One native relates of a race of tailed men that they sit with their tails hanging through holes in the floors of their pile-dwellings. While among them, he used, for a joke, "to creep under the house, take hold of each tail very gently and tie a knot in it"; then raise an alarm, with the result that the caudate warriors, springing up to meet the foe, were jerked on their backs by their own tails. Another has conclusive evidence of the existence of one tailed man at least, "Because I eat him!"—all fairly strong evidence, remarks Mr. Murray, if not of the existence of men with tails, at least of lively imaginations. And so we are taken through interesting chapters on the People, History, Exploration and Development. One is struck with the sympathetic and far-sighted policy of the Australian Government which guides the destinies of the Possession, and recognises in Mr. Murray, who is the Lieutenant-Governor, a wise and thoughtful exponent of it.

We do not think the introduction very fortunate, and the two first chapters, on the geography, are certainly the least interesting. The numerous photographs are excellent, but the map is not very satisfactory, and there are a few misprints. The index is good.

A. S.

The Earth, its Shape, Size, Weight and Spin.—By J. H. POYNTING, Sc.D., F.R.S. 141 pages. 49 figures. 6½-in. × 5-in.

(The Cambridge University Press. Price 1/- net.)

In three chapters, on "The Shape and Size of the Earth," "Weighing the Earth," "The Earth as a Clock," Dr. Poynting has collected for the student and the general reader a great deal of useful information on certain branches of earth-knowledge for which one has usually to search large and difficult treatises, and the information is presented in such a way that it is acquired really as scientific knowledge, not merely as positive fact is got from the usual popular book. The student must have a preparation in Mathematics and Physics, but the general reader will read with profit though his equipment be less.

Very fresh and stimulating is the treatment of Relative Motion, Precession and Nutation, and most of the part on the Tides. Frequently the expression is striking and illuminating. It is characteristic of many of the Cambridge Manuals that exactly as the reader knows more he learns more, and this is even more than usually true of the present volume. One complains of some things that might be easier to follow, as at pages 11–12, 58, 115. These are but slight faults in a book elsewhere remarkably excellent, which is well got up, and has a good index.

A. S.

GEOLOGY.

The Geology of Soils and Substrata.—By H. B. WOODWARD, F.R.S., F.G.S. 366 pages. 44 text-figures. 4 plates. 7½-in. × 5-in.

(Edward Arnold. Price 7/6 net.)

The aim of this book is to provide the necessary geological information for agriculturists, and those engaged in the management of estates, in sanitary or engineering work—in short, any business which involves some knowledge of the soil and subsoil. The practical importance of geological knowledge is nowhere brought out more fully than in connection with agriculture, sites for houses and cemeteries, sewage disposal, and kindred applications of the science. In our opinion, Mr. Woodward has fully achieved the object with which he set out. In the book is brought together an immense amount of geological information on subjects that are rarely even mentioned in the text-books, and it is a special convenience to have it set out so clearly in this book.

The first six chapters provide such general geological knowledge as is necessary for the study of the soil and subsoil that follows. The next eight chapters deal with every conceivable phase of agricultural work in which geological knowledge is a desideratum. For instance, besides the method of formation of soils, we are shown how climatic and other conditions affect its fertility or cause its barrenness. This leads to a discussion of the drainage necessary to increase the fertility and workability of the soil, and of the geological principles involved.

Next are described the mineral manures which it may be necessary to apply in order to make up some natural deficiency in the soil. Then come chapters on the geological features to be studied in connection with forests, woodlands, orchards and gardens; and the practical geological considerations in respect to estate management, and economic materials (such as road-metals) derived from the soil or subsoil. The chapter dealing with the geology of sites for houses, cemeteries, sewage

farms, water supply and ponds, is of special value. The remaining chapters describe the soils and subsoils derived from each of the various geological formations in Great Britain, and in this part of the book a large amount of practical information has been brought together. At frequent intervals there are appended good lists of references, and the book is illustrated by excellent plates and text-figures.

G. W. T.

ZOOLOGY.

Comparative Anatomy of Vertebrates.—By J. S. KINGSLEY. 401 pages. 346 illustrations. 9-in. × 6-in.

(John Murray. Price 12/- net.)

With such a multitude of works on the anatomy and anatomical evolution of the vertebrata already before the public, it might well have been thought that there was scarcely even standing room for a new one. Such, however, is evidently not the opinion of Professor Kingsley, who occupies the chair of Biology in Tuft's College. Apparently, as a reason for the new venture, it is stated in the preface that the modern method of teaching biology in the laboratory, by means of dissection, does not constitute a science, and that it is consequently essential that the facts so collected "should be properly compared and correlated with each other, and with the condition in other animals. It is the purpose of the author to present a volume of moderate size which may serve as a framework around which these factors may be grouped, so that their bearings may be recognised, and a broad conception of vertebrate structure obtained. In order that this may be realized, embryology is made the basis, the various structures being traced from the undifferentiated egg into the adult condition."

That Professor Kingsley has done his work thoroughly and in first-rate style every student who has cause to make use of the book can scarcely fail to admit: the amount of information which has been crammed into such a small space being little short of marvellous, especially when the number and, in some instances, the relatively large size of the illustrations are taken into consideration. For excellence of execution, cleanness of detail, and suitability to their respective purposes these illustrations can scarcely be surpassed. In the legend to Figure 92, we notice, however, that the American fashion of applying the term "turtle" to a fresh-water "tortoise" is retained; and we cannot approve of the practice, as exemplified in the same illustration, of referring the reader to a figure twenty pages earlier for an explanation of most of the lettering. Neither do we like the Americanism of spelling the name of the European pond-tortoise *Emys europea*. Save for trivial criticisms of this nature, we have nothing but unqualified praise to bestow upon Professor Kingsley's book, which ought to have a wide circulation among university and other students.

R. L.

Heredity.—By Professor J. ARTHUR THOMSON, M.A. 627 pages. 47 illustrations. 8½-in. × 6-in.

(John Murray. Price 9/- net.)

Professor Thomson is to be heartily congratulated on the issue of a second edition of this volume, which forms the best semi-popular text-book on this interesting and important subject, and is long likely to maintain this enviable position. Apparently, the new edition has not required much alteration, with the exception of the correction of a few errors; but the author has taken the opportunity of adding references to papers embodying discoveries made since the appearance of the first edition.

Doubtless many of our readers are familiar with the work in its original form, and to these anything like a review would prove wearisome; those who have not yet made its acquaintance are recommended to remedy the omission with the least possible delay. For heredity is a subject in which we are all nowadays more or less practically and directly interested in—or, if we are not, we ought to be; and whether we believe or disbelieve in eugenics as a potential factor in modern life, we ought at all events to be acquainted with the arguments in favour of the new doctrine.

To the general reader, perhaps, the most interesting part of the work is contained in the concluding sections, where the author reviews the effects of heredity on the present population of our country. After referring to the well-ascertained fact that while the children of exceptionally gifted parents are not infrequently worse than commonplace (as if nature had exhausted herself in the special mental development of the former), those of parents of a low type are often very fair examples of the human species, Professor Thomson proceeds to discuss the question whether modern therapeutic and hygienic methods tend to prevent the elimination of weaklings, and thus lead to the deterioration of the race as a whole. Here it is pointed out that insanitary surroundings, and the consequent epidemics, affect the strong as well as the weak, while the latter may in some cases develop mental character not vouchsafed to the former. On the other hand, the question whether bodily weaklings should be permitted to transmit their failings presents a more serious question.

Whether the relatively unfit should be allowed to multiply is another serious question of the same nature, which the author answers unhesitatingly in the negative. The burden of militarism, and the consequent destruction from time to time of the flower of our manhood, is also discussed at some length, with the suggestion that certain kinds of deterioration may be due to this cause. With this we take leave of a fascinating volume, on which the reading and thinking world has already bestowed its imprimatur of appreciation.

R. L.

Problems of Life and Reproduction.—By MARCUS HARTOG. 362 pages. 41 illustrations. 8½-in. × 5¾-in.

(John Murray. Price 7/6 net.)

We learn from the preface that the author, when incubating the idea of this volume, had in his mind to write a general treatise on reproduction suited to the needs and capacity of the non-scientific reader. Further consideration indicated the existence of certain reasons against such a mode of procedure, and these reasons—to our thinking, unfortunately—ultimately prevailed. The author found, however, that he had already written certain articles on reproduction—one so long ago as 1892; and these, with others on more or less distinct subjects, have been collected and reproduced, with such alterations as were deemed essential, in the present volume, which is consequently a kind of scientific *olla podrida*, and a very mixed one at that. For it includes such diverse topics as reproduction and fertilisation, the transmission of acquired characters, mechanism and life, the biological writings of Samuel Butler, the teaching of nature study, and—what we venture to suggest will prove a regular stumper to the man in the street—the new force, mitokinetism. But whatever Professor Hartog writes, even if it be a bit unduly technical and in a somewhat involved style, is worth reading; and those readers of "KNOWLEDGE" who wish to have even a bowing acquaintance with some of the up-to-date subjects of modern scientific thought, will do well to at least dip into his pages.

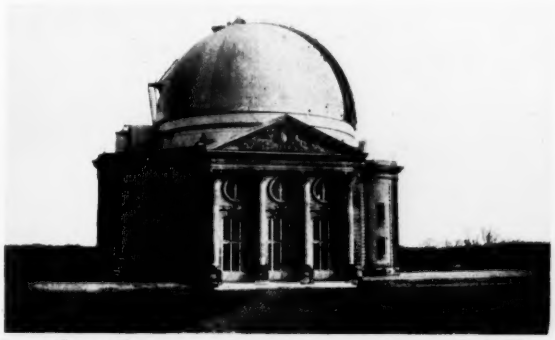
With such a multitude of subjects before him, the unfortunate reviewer who is expected to give something like a comprehensive notice of the book, within the compass of a few short paragraphs, must be completely and hopelessly nonplussed. Personally, we have been most interested in the article on the inheritance of acquired characters; but we are somewhat disheartened by a footnote at the commencement to the effect that another author has collected a number of facts in favour of this theory since the first appearance of the article, which ought surely to have afforded sufficient reasons for rewriting. Among Darwinists who hope to attain the Valhalla of orthodox followers of their doctrine, anything approaching recognition of the possibility of inheritance of acquired characters (for what these are we must refer our readers to the pages of our author) is anathema, but Professor Hartog, being a bold spirit, runs a-tilt at the objectors, and demonstrates to his own satisfaction, at any rate, that such characters can, at least in some instances, be transmitted to the offspring. Whether he will have succeeded in convincing the orthodox Darwinists of the error of their ways is quite another matter.

R. L.

CONSIDERATIONS ON THE PHYSICAL APPEARANCE OF THE PLANET MARS.

By E. M. ANTONIADI, F.R.A.S.

IN the year 1877, our knowledge of the markings which variegate the surface of Mars was in a very satisfactory condition. A series of excellent observations by Dawes, Lockyer, Lassell, Kaiser, Burton, Green, and others, had disclosed the true natural structure of the spots on that planet. The



From a photograph by the Writer.

FIGURE 183. View of the Great Dome of the 33-inch Refractor at Meudon.
Height of the ground above sea level, 533 feet.

question thus appeared definitely settled, when it was troubled by the Italian astronomer Schiaparelli,* who announced that linear objects, to which he gave the name of channels, or canals, were furrowing the so-called continental regions of our neighbour in space. During the apparitions of Mars following the year 1877, the Milan observer continued and extended his discoveries; his later maps seemed practically covered with spider's webs; while the zeal and discernment of his followers could number no less than one thousand different canals on the yellow or grey expanses of the planet.

Gigantic watercourses, mostly running along great circles of the sphere, and, consequently, appearing straight near the centre of the disc, continued to look straight in Italy even when nearing the limb of Mars. A geometrical cross of canals in the land called Hellas was seen attended with four symmetrical bright specks of light, recalling somehow to memory the *In hoc signo vinces* of the emperor Constantine. Canals, scores of miles wide, and hundreds of miles long, were observed in a few days, or even hours, to double, either by the formation of a parallel band, or by the disappearance of the original canal, and by the formation of two new parallel streaks separated by hundreds of miles. Nor were hesitations in these doublings neglected to be put on record, since canals were seen to be alternately single and double on the same night.

To account for these wonderful phenomena, the vast powers of Nature were found totally inadequate; and thus it was that Schiaparelli was led to enunciate the idea of the artificial origin of the canals, conceiving the larger of them to be composed of six different watercourses, whose dykes would be opened now and then by the Martian minister of agriculture.

Speculations of such a character were eagerly embraced by M. Flammarion and other popular Continental writers. Yet it is to be regretted that the originator of this artificial theory, and his imitators, have failed to do the utmost with their cherished idea. For, inasmuch as the canals appear straight about the central meridian, and also when carried by rotation near the limb, it is obvious that the Martian engineers would be constantly engaged in rapidly digging and destroying their watercourses, so as to make them look always straight to the observers on the Earth.

It is to the credit of British science that the results of Schiaparelli were, from the very onset, strongly controverted by English astronomers. In 1879 Green boldly questioned the reality of these canals. In 1882 Mr. Maunder and Mr. (now Sir) William H. M. Christie rightly insisted on the error of Schiaparelli in using too high powers. But the honour of first recognising the true nature of the minor detail of the planet is due to Mr. W. F. Denning, who announced, as far back as 1886, that the continents of Mars show

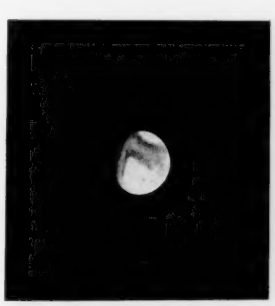


FIGURE 184. The Laestrygon. 1896, June 12.

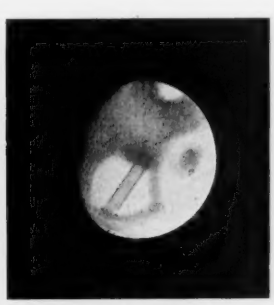


FIGURE 185. The Jamuna. 1894, August 27.

Single and double Canals of Mars, as glimpsed for a quarter second by the Writer.

here and there some irregular streaks, presenting frequent interruptions and condensations. As is wont

*This view of the discovery of the canals was given by Mr. Maunder, in "KNOWLEDGE" for 1894, p. 249.

in such cases, this statement attracted no attention at the time; and it was only several years later that it received full confirmation at the hands of Professors Young, Barnard, Hale, and the writer, all observing with very powerful telescopes. And when we recollect that Mr. Denning used in this enquiry only a ten-inch reflector, and that he made his innumerable other discoveries in an unfavourable climate, and under difficult circumstances, we deem it only just to consider him as the greatest of all modern observers.

The canal problem, thus solved by observation, was next approached from the point of view of theory. In 1894-1895, Mr. Maunder laid stress, in these columns, on the error of believing that our telescopes reveal to us the ultimate structure of the surface of the planet. As a consequence, he expressed his conviction that the canals are only the summation of a complexity of detail, comparing them with the linear appearance to the naked eye of an irregular stream of sunspots. This is the key to the whole question. "I quite agree with you," says so high an authority as Professor Barnard, in a letter to the writer, "in respect to Mr. Maunder's

FIGURE 186. Schiaparelli. 1883–1884.

FIGURE 187. The Writer. 1909.

The "Canals" Laestrygon, Antaeus and Tartarus, as seen in an aphelic apparition with an 8½-inch, and in a perihelic apparition with a 33-inch Refractor.

FIGURE 188. Schiaparelli. 1883–1884.

FIGURE 189. The Writer. 1909.

The "Canal" Eosphoros in an aphelic apparition with an 8½-inch, and in a perihelic apparition with a 33-inch Refractor.

As a patient record of fleeting impressions, his results stand unrivalled; while his splendid triangulation of the Martian surface has victoriously resisted the test of time.

An unsympathetic feature of most planetary drawings is the regularity of their markings. Scientific candour is partly responsible for this, as the truthful observer will avoid the impossibility of sketching complex irregularities which he is only glimpsing, rather than introduce elements of doubt in his delineation. A less excusable reason for geometrical outlines may be sought in a widespread disregard of angular diameters. In fact, areographers too frequently forget that Mars is usually seen as a sixpenny piece held at the distance of two feet from the eye; and that what is sharp on such a small disc, so far off, ought to be represented as exceedingly vague on drawings three inches in diameter, seen at the distance of one foot only.

The student who passes many consecutive hours in the study of Mars with medium-sized instruments, is liable to catch rare glimpses of straight lines, single or double, generally lasting about one quarter of a second (see Figures 184 and 185). Here we have a vindication of Schiaparelli's discoveries. But their deceitful character will obtrude itself on the observer using a large telescope, when, in the place of the lines, he will hold steadily, either a winding, knotted, irregular band, or the jagged edge of a half-tone, or some other complex detail (see Figures 186 to 189).

In their anxiety to prop their views against natural law, believers in the reality of the linear canals have presumed to champion the alleged superiority of small over large telescopes; and this

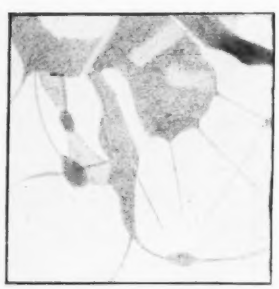


FIGURE 190. September 18. V. Fournier. Jarry Desloges Observatory. 11½-inch Refractor.

FIGURE 191. September 20. The Writer. Meudon Observatory. 33-inch Refractor.

FIGURE 192. October 5. From a photograph by Professor Hale. 60-inch Refractor.

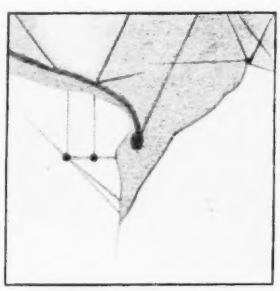


FIGURE 193. November 3. Professor Lowell. 24-inch Refractor, stopped down to some 15 inches.

Views of Syrtis Major and Lacus Moeris in 1909 with various telescopes.

work in trying to clear up the tangle about the canals of Mars. I think he has thrown much light on the subject."

Many able observers believed that Schiaparelli had imagined all his system of spider's webs. But this is quite unfair, as, with the exception of an abuse of magnification, the errors of Schiaparelli were errors of judgment, and not of observation. Although the constant use of high powers made him lose the half-tones of Mars, his outlines of the dusky areas are usually more accurate than anything ever drawn with a telescope of the size he used.

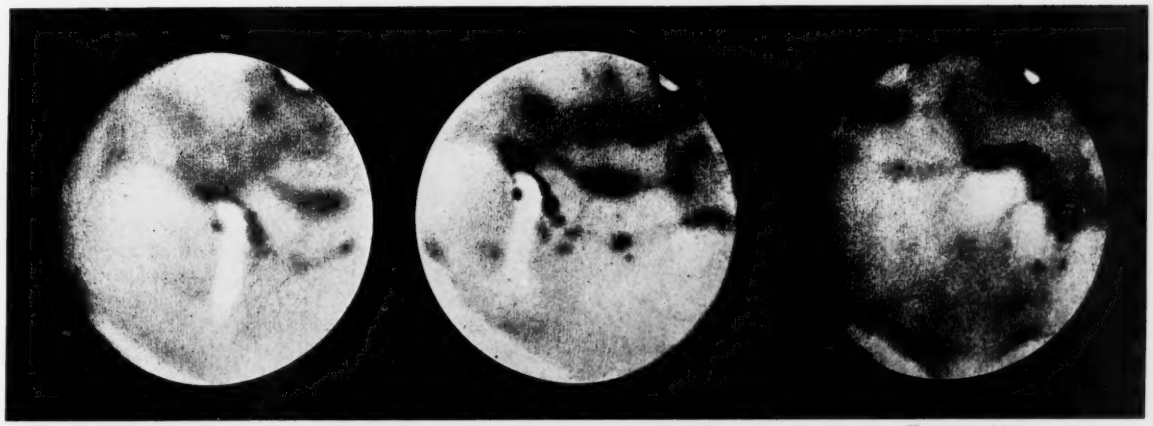


FIGURE 194.
1911, October 28^{d} 22^{h} 19^{m}.
Longitude = 58°.

FIGURE 195.
December 4^{d} 22^{h} 0^{m}.
Longitude = 87°.

FIGURE 196.
October 20^{d} 21^{h} 35^{m}.
Longitude = 120°.

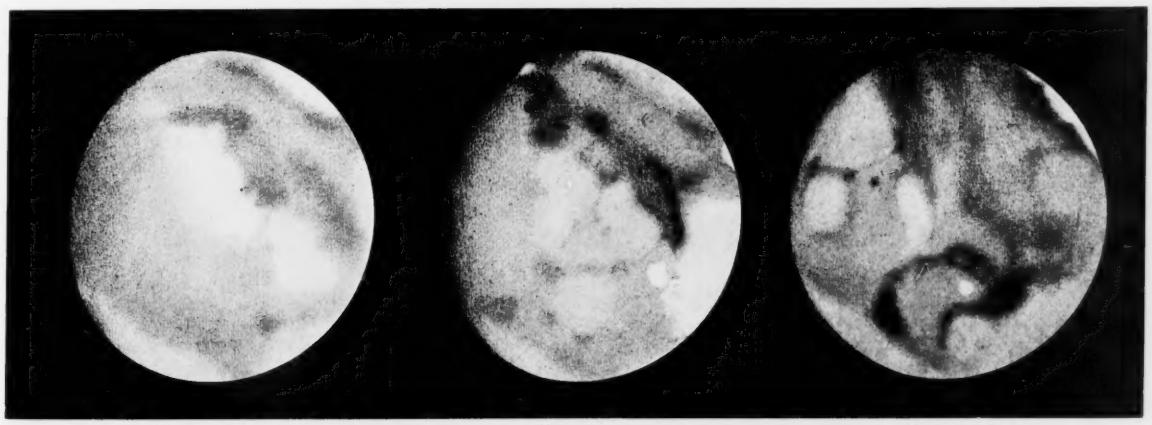


FIGURE 197.
October 17^{d} 21^{h} 55^{m}.
Longitude = 152°.

Figure 198.
October 14^{d} 23^{h} 0^{m}.
Longitude = 195°.

FIGURE 199.
October 14^{d} 21^{h} 30^{m}.
Longitude = 255°.

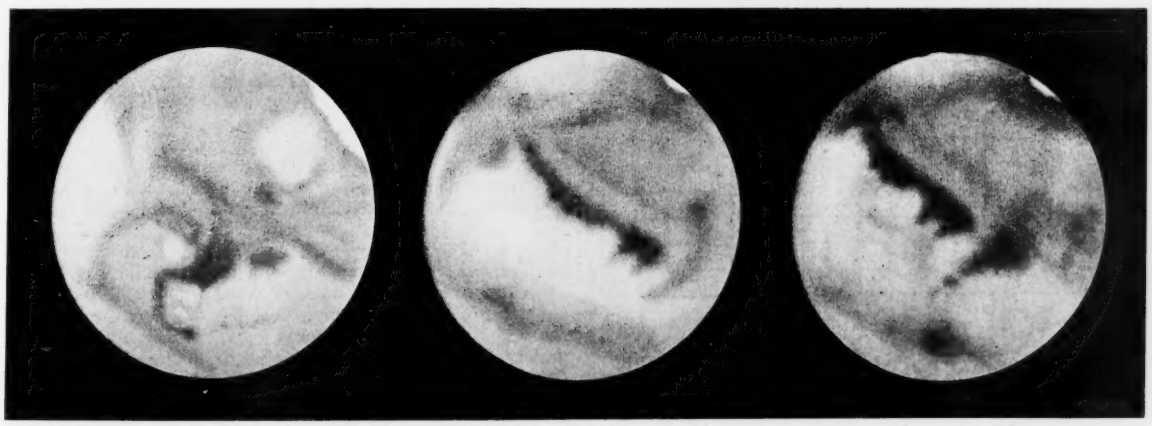


FIGURE 200.
November 13^{d} 22^{h} 45^{m}.
Longitude = 282°.

FIGURE 201.
November 6^{d} 22^{h} 15^{m}.
Longitude = 337°.

FIGURE 202.
November 3^{d} 21^{h} 48^{m}.
Longitude = 357°.

Observations of Mars in 1911, made by E. M. Antoniadi, F.R.A.S., with the 33-inch Refractor of the Meudon Observatory, magnifying 320, 540, and 810 diameters.

(Published by kind permission of Professor Henri Deslandres, A.R.A.S., of the French Academy of Sciences, Director of the Astro-physical Observatory of Paris, situated at Meudon (S.-et-O.), France.)

XUM

either in revealing planetary detail, or in separating close double stars. But the attempt has been defeated, both by theory and observation; (*a*) by theory, because of the law of diffraction, which proves that the defining power of a telescope increases with its aperture; and (*b*) by observation, from the evidence of the facts themselves. A comparison of the appearance of Syrtis Major on Mars with various instruments in 1909, when the weaker telescopes revealed inexistent lines while failing to show the coarsest details (see Figures 190 to 193) will establish for ever their hopeless inferiority. Nor was the smaller instrument more fortunate on double stars. A spurious satellite to Sirius was discovered and measured in an impossible position in 1896, with a refractor of moderate power. But when the question of finding the true satellite was seriously raised, the discovery was naturally made with the thirty-six inch equatorial of the Lick Observatory, one of the most powerful instruments in existence.

Thus it is that diffraction fetters the efficiency of small telescopes; and their comparison with large ones is as childish as the attempt to bombard a fortress twenty miles off with guns whose range is only eight.

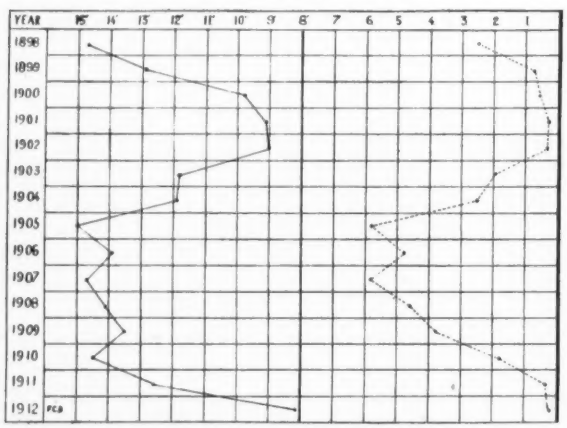
Such the errors foisted on the scientific world, and such the arguments leading to their final refutation. Yet truth will seldom receive acceptance without strenuous opposition. The laws of perspective will again be curbed by the evidence of lines appearing straight in all positions of a rotating globe. Some observers will continue proclaiming the superiority of small telescopes. Ponderous volumes will still be written to record the discovery of new canals. But the astronomer of the future will sneer at these wonders; and the canal fallacy, after retarding progress for a third of a century, is doomed to be relegated into the myths of the past.

STONYHURST COLLEGE OBSERVATORY.

By FRANK C. DENNETT.

THE report of this useful observatory for the year 1912 has just been issued by its Director, the Rev. Walter Sidgreaves, S.J., F.R.A.S. The mean barometric pressure for the year was ·054 inch below the average of the previous sixty-five years, and so lower than 1911. Only in the months of April, September, October and November was it above the month's average; September yielding the highest mean, and March the lowest of the year. The rainfall was nearly seven and a quarter inches above the annual average, for which the excessive rains in March, June, August and November were largely responsible. During March the fall was half an inch above double the usual fall, being 7·205 inches, the greatest during the previous sixty-five years. April proved the finest month, the only one with the duration of sunshine above its average, and its rainfall little more than half its average. The total duration of sunshine during the year was only 927·6 hours, or 409·6 hours short of the annual average, the smallest on record for thirty-two years. The dullest months, March, June, August, and December all yield the lowest number of shining hours previously on record. The year, notwithstanding the small amount of sunshine, proved a mild one, for though the summer was below the average, the winter was above. The mean temperature for the year was 47°·5, or 0°·6 above the average. Only on five days the wind attained the velocity of a gale, the strongest being on April 6th and 8th, when the record stood at forty-five and forty-six miles per hour. Magnetic records appear to be missing on three days, September 30th, November 18th and 19th. Of the rest, one hundred and twenty-four days are recorded as calm, two hundred and twenty small disturbance, eighteen moderate, and only one, October 14th, as great, no very great disturbances being recorded. The mean daily range of the Declination magnet in arc minutes was 8′·1, the lowest of the past eighteen years. The lowest monthly mean daily range, 6′·1, was in January. The mean area of sunspots (in units of $\frac{1}{5000}$th of the visible surface) appears at 0·22. Compared with previous years, together with the magnetic declination range in graphical form, it seems to show that 1912 marks the minimum of sunspot activity. The diagram is constructed by the writer from the Stonyhurst records since 1898, and is perhaps more striking than figures. The spectrum of Nova$_2$ Geminorum was photographed on seven occasions, besides being observed visually on other nights. Gale's and Borelli's comets were both photographed and observed, but not under favourable conditions.

TABLE 39.



Magnetic mean declination range. Mean daily spot area.

One sentence in the report we note: "It has been decided at the Meteorological Office to reduce the number of its observing stations; and our connection with the office ceases at the end of March. But the automatic recorders are to remain here, and will be kept in active service."

TRYPANOSOMES.*

By MALCOLM EVAN MACGREGOR, F.R.M.S.

CONSIDERING the great amount of attention trypanosomes have demanded, and are still demanding, in many tropical and semi-tropical countries, it will be the endeavour in this paper not so much to present a scientific or in any way thorough description of the organisms called trypanosomes, but more to give a brief survey of a few of the aspects of general interest that are met with in their study.

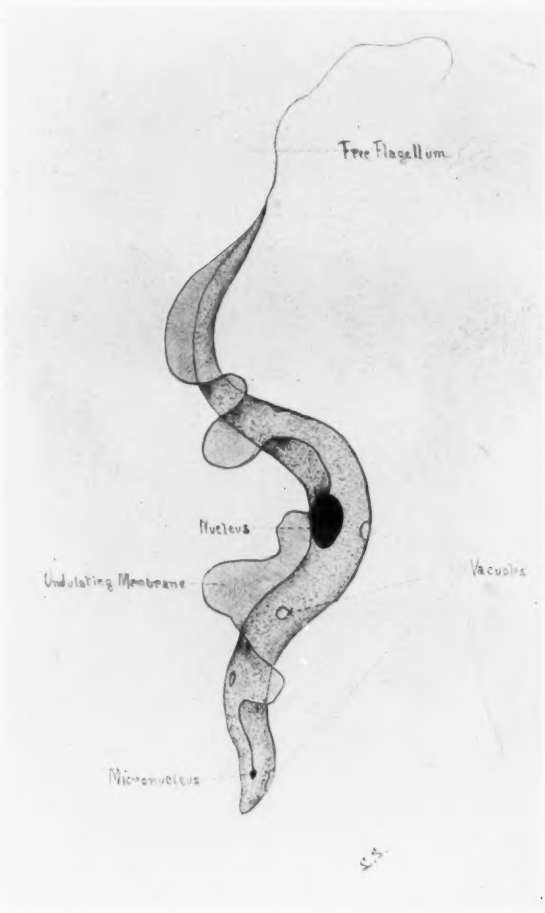
Trypanosomes belong, in the animal classification, to the Phylum Protozoa, and are parasites in the blood of vertebrate animals. They are minute unicellular organisms of somewhat eel-like shape, and range in length very widely: from seven to thirty microns being about the commonest variation.

First discovered in the year 1841, by Valentin, in the blood of a fish, they have since been found in the blood of nearly all vertebrates, and while some species of trypanosomes do little, if any, harm to the animal in whose blood they live, and where they may swarm; other species, if present only in the smallest numbers, produce most terrible results.

Such diseases, for instance, as sleeping sickness, Nagana (the fly-sickness of cattle in Africa), Dourine (a horse-sickness in India), Mal de Caderas, of South America, a human disease that occurs in the same country, and many others, are all diseases due to trypanosomes; so that trypanosomes in some parts of the world have to be looked upon as one of man's deadliest enemies: an enemy over which, as we shall see later, he has yet been able to get but the smallest victory.

It was, as already stated, Valentin in 1841 who discovered the first trypanosome, and this he did in the blood of a trout; but it was not until 1880 that Evans, working in India discovered the first pathological trypanosome. This was the trypanosome that produced the disease in horses and camels, called Surra. Fourteen years afterwards, in 1894, came Bruce's discovery of a trypanosome as the cause of Nagana (or fly-sickness) in Africa.

In 1901, Dutton discovered a trypanosome in the blood of a European in the Gambia, which he appears at first not to have quite realised the significance of. In the May of 1903, Castellani, while examining the cerebro-spinal fluid of a native suffering from sleeping sickness, discovered in this fluid a trypanosome, and it was he who first connected the organism with the disease.



From a Drawing by *Count L. de Sibour.*

FIGURE 203. *Trypanosoma gambiense.*
The most salient structural details of a Trypanosome.

MORPHOLOGY.

The Morphology is extremely simple (see Figure 203). The body consists of an elongated mass of protoplasm tapering anteriorly to a fine point, and ending posteriorly rather more bluntly. The body protoplasm is often very granular, and often shows vacuoles in it.

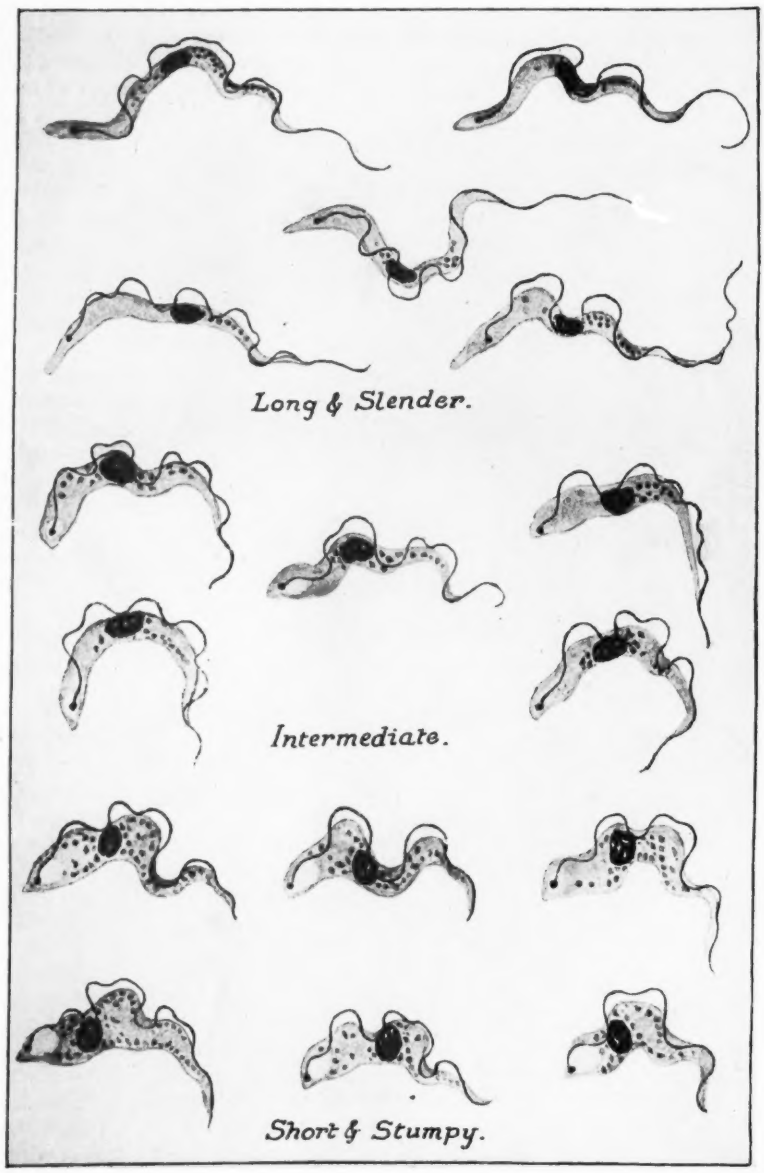
About the centre of the body the structure known as the nucleus is generally situated, but oftentimes it is found more anteriorly placed, and at other times it is in quite a posterior position. In shape the nucleus is usually oval or resembling the shape of a bean, and stains a dense purple-blue colour with the ordinary trypanosome stains. The chief function of the nucleus is thought to be the governing of the functions of the protoplasm (the metabolism and katabolism), and it is hence sometimes called the "tropho-nucleus" to distinguish it from another small mass of nuclear material that occurs in the

* Being the subject-matter of a lecture delivered before the Cambridge Natural History Society, February 20th, 1913.

body of the organism, namely, the Micronucleus. This occurs usually quite posteriorly in the body, and it is thought that its function is to govern the movements and reproduction phases, and hence it is sometimes called the "kinetonucleus."

The "undulating-membrane" is a finlike ridge or fold of the body protoplasm, and lies to one side of the body. Being longer than the body-length, as will be seen in the illustrations, it is cast into many wave-like folds. It is a very delicate membrane of very variable width, being in some trypanosomes so narrow that it is almost impossible to make out: at other times it is considerably broader even than the body-width. It constitutes an organ for swimming.

From the micronucleus there arises a thread of nuclear material called the "flagellum," which runs forward anteriorly along the body, bordering the extreme edge of the undulating-membrane, as far as that goes, and then proceeding beyond the anterior end as a free thread or lash, called the "free flagellum." This may extend to twice the body-length. Its purpose is also for swimming.



By permission of The Tropical Diseases Bureau.

FIGURE 204.

Trypanosoma gambiense × 2,000, showing types. After a plate by Lady Bruce (Royal Society Proc. B. vol. 84.)

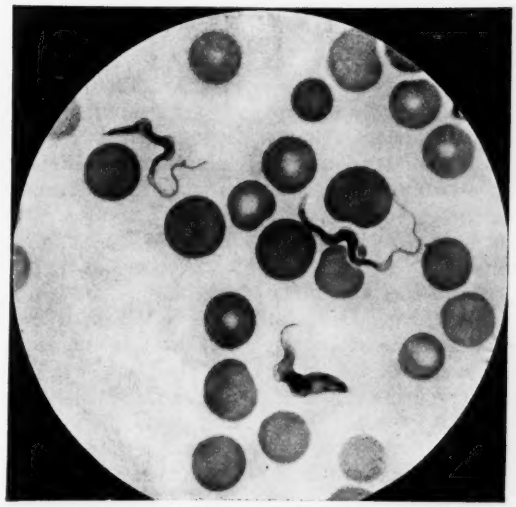
Trypanosomes are essentially very "lively" creatures, and most, while capable of swimming actively in the blood by means of the undulating-membrane, and free flagellum, are also capable of wriggling and twisting movements. All the movements in healthy trypanosomes are generally very violent, and the blood corpuscles are thrown in all directions as the organisms dart here and there.

The movement of the undulating membrane has been very aptly compared to the flapping of a boat's sail that has "lost the wind." It is an exceedingly graceful movement, and travels as a rippling wave over the entire membrane. The direction of the waves vary according as to whether the animal travels backwards or forwards. The movements of the flagellum are almost impossible to make out as only their effects on the surrounding medium give one any indication of what they are; but they must obviously be some systematic series if they are to benefit progression. It is due to the rapidity of the movements of trypanosomes, that trypanosomes, while they are living, are such extremely difficult subjects to study. In the case of *T. vivax*, a particularly lively creature, all that can be seen in the medium in which it exists are rocket-like paths as the trypanosome dashes across the field of the microscope.

Trypanosomes multiply in the blood of their hosts

by longitudinal fission. The micronucleus is first seen to divide into two, splitting, as it does so, the flagellum into half, so that each of the two new micronuclei has a strand of the flagellum attached to them. The splitting of the flagellum then proceeds through the whole length, the nucleus divides into two, and by fission in the protoplasm, the organism becomes two separate individuals, usually of unequal size. The reproduction phase probably has a far more complicated cycle than this, however, even when reproduction in the blood of the host is only considered, to which the above description refers; but beyond this fission-method of reproduction nothing is yet sufficiently definitely known to need mention here. In the alimentary canal and salivary glands of the tsetse-fly, the reproduction phase of trypanosomes is exceedingly complex.

The remarkable diversity in size and shape that is found in trypanosomes of any one species living in the blood of an animal is striking. They may vary from slender organisms of great length, possessing highly developed undulating membranes, and long free flagella, to quite short, stumpy organisms entirely wanting both these appendages. What the complete significance of this series is we are at present unable to say, but some are probably younger individuals, and it seems likely that the stumpy type are of a more resistant kind than the long type, since it is they that are most numerous in the blood when the host is fighting the disease, or when drugs are given to the animal that render its blood unfavourable to the development of the trypanosome. Figures 204 and 205 show various types of the same organism.



By permission of Professor Minchin and The Cambridge University Press.

FIGURE 205.

Trypanosoma gambiense from blood of rat. × 1,000.

(Smear fixed out with osmic acid vapour, and stained by Giemsen. A slender, a stumpy, and an intermediate form are seen. From plate illustrating Professor Minchin's paper in Parasitology, 1. No. 3.

Natural size.

Magnified 13 diameters.

By permission of The Tropical Diseases Bureau.

FIGURE 206.

Glossina palpalis Rob-Desv. The tsetse fly.

A good representation of the resting fly, but in life the palpi would be appressed, and light would not be visible between them. From a photograph by Dr. W. M. Graham, Director of the Medical Research Institute, Lagos, S. Nigeria.

DISTRIBUTION.

Trypanosomes occur all over the world, and those found infecting wild animals in nature, are, as a rule, quite specific to a particular host, and so far as can be observed, perfectly harmless to it, but there are some which infect man and animals, and are highly pathogenic. Such, for instance, is *Trypanosoma gambiense*, the parasite that produces Sleeping Sickness. It is pathogenic to all animals as well as man. *T. brucei*, the trypanosome that is so deadly to the cattle and domestic animals in Africa, gives rise to the disease called Nagana or Fly-sickness; but it is *harmless* to man, for it is unable to exist in his blood.* An example of a trypanosome that is harmless to its host is to be found in *T. lewisi*. This trypanosome is quite specific to rats, and though it may swarm in the blood, so far as can be seen, it has no harmful effect on them, and as soon as the infection has reached a certain stage the number of trypanosomes steadily decreases in the blood, finally disappearing altogether, and leaving the rat quite immune to a second infection.

A marked contrast to this state of affairs is found in the case of the trypanosome of sleeping sickness. Here, at no time in the course of the disease in man and many animals, are the trypanosomes ever very numerous, and though their deadly effect may be highly manifest in the infected animal, their presence in the blood may be exceedingly difficult to detect, owing to the extreme scarcity of the parasites.

* Since the above was written it has been stated, positively, that the cases of sleeping sickness in Nyasaland are due, not to a specific trypanosome called *T. rhodesiense*, but that this trypanosome (*T. rhodesiense*) turns out to be none other than *T. brucei*, i.e., the parasite that produces Nagana. (See paper by Sir D. Bruce and others, Royal Society's Proceedings, Biological Section, April 7th, 1913). This shows how indefinite much of our knowledge of these organisms still is. For all there is to the contrary, we may very well find ere long, that one half of what are looked upon as distinct species, are one and the same organism, altered slightly, it may be, by its adaptation to different environments.

XUM

Trypanosomes depend for their transmission from one animal to another, with very few exceptions, on the agency of blood-sucking invertebrates, which we may call "the carriers."

Thus the trypanosomes of fishes are transmitted by leeches from one fish to another; the trypanosomes of rats, by the rat-flea; the human trypanosome (*T. cruzi*) of South America, by a hemipterous insect; the trypanosome of sleeping sickness and the cattle disease of Africa, by a blood-sucking fly of the genus *Glossina*; and so on.

The trypanosomes having entered the alimentary tract of the carrier in a meal of blood from an infected animal, there undergo a developmental cycle, and it seems most probable that not until this cycle is complete are they able to infect other animals, when the blood-sucking fly or carrier feeds. They enter the blood stream of the new host in the secretion the fly pours out through its proboscis preparatory to commencing its meal.

DISTRIBUTING FACTORS.

Glossina palpalis, (see Figure 206) the carrier of sleeping sickness, is a fly not unlike a common house fly in appearance, though it has a proboscis for piercing the skin of animals in place of the house-fly's suctorial pad, or so-called tongue. There are fifteen different species of *Glossina* already known, but only two or three of these species can be incriminated in spreading disease, as it has been found that only particular species can act as carriers of trypanosomes. All the flies of this genus, except for minor differences in the species, have much the same life-habits, so that a description of one will more or less apply to all. We will deal with *palpalis*.

This fly, like several species of tsetse flies, lives near the banks of rivers or lakes, and is found, fortunately, in only a comparatively small area of Africa's vast extent. The fly is not naturally infected, but has first to partake of a meal of infected blood before it becomes so. It then only is capable of infecting people, when it bites them, after a certain interval has elapsed — a few hours — and the period while it is capable of infecting people lasts only for a certain number of days. To become reinfective the fly must again feed on infected blood. Both sexes suck blood, and it is in the early morning and at sun-down that they are most vigorous in this pursuit. Rarely they feed at night-time, when the moon is bright. The fly having settled and pierced the skin of its victim, can become gorged with blood in from twenty to thirty seconds. The bite is hardly more painful than that of a mosquito or gnat, and there is a similar slight swelling at the site of the bite. The name "tsetse" is a Zulu word, and is supposed to describe the peculiar high-pitched buzzing of the insect's wings in flight, as it passes within one's range of hearing.

It has been calculated that the number of flies that are infected at any one time is small, and so a bite from one does not necessarily mean to contract sleeping sickness; but the fearful havoc that even this small percentage can work will be understood when it is said that between 1901–1912 in Uganda alone, a very low estimate of the number of victims is about one hundred and fifty thousand to two hundred thousand people. Whole tribes of natives have in some cases been exterminated.

The flies do not lay eggs, but produce their young, one at a time, in the pupa stage. These they deposit in the dry sand below the undergrowth on the bank of watercourses, and the pupae, burrowing their way a few inches below the surface, there undergo a metamorphosis, and ultimately emerge as fully developed flies. This metamorphosis is completed in about six weeks.

These are quite healthy, and as already said, cannot cause disease by their bites until they have fed on the blood of an infected animal. Therefore, the question naturally arises, "Where is the reservoir of the disease by which these flies become infected?" That question cannot unfortunately be quite satisfactorily answered at present. The big game of those parts have been blamed, and although it has not been definitely shown yet that they are responsible, evidence is every day accumulating against them.

It was at first thought that the crocodile was the reservoir, as *palpalis* was known to feed on them, and in their blood was very commonly found a trypanosome very similar to *T. gambiense*, and which was at first mistaken for it. But it has now been proved to be a different parasite.

(To be continued.)

NOTICES.

"LIQUID AIR OXYGEN NITROGEN."—Messrs. J. and A. Churchill announce that they are about to issue a translation of this book, which is by Mr. Georges Claude. It will be of particular importance to Agriculturists in this country, as considerable attention is devoted to Nitrogen.

CATALOGUES.—We have received Mr. John Wheldon's Entomological Catalogue which contains the titles of about fourteen hundred books and papers dealing with all orders of Insects, together with Spiders and Myriapods.

Mr. Charles Baker's classified list of second-hand instruments for April, 1913, is before us, and should prove as useful as any of its predecessors.

MISS FLORA WINSTONE.—We very much regret to hear that Miss Flora Winstone, for many years assistant editor of *Hardwicke's Science Gossip*, died on the 22nd March at South Norwood.

PHOTO-MICROGRAPHY.—We would remind our readers that the demonstrations on this subject which Mr. Senior is to give begin on Monday, May 5th, at the South Western Polytechnic.